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EBASCO SERVICES INCORPORATED

FINAL DRAFT

PRELIMINARY GEOTECHNICAL INVESTIGATION OF ENGINEERING PROPERTIES

NEW BEDFORD HARBOR

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Prepared by:

Roddy Sherer

Roddy Sherer
E.C. Jordan Co.

Submitted by:

Allen J. Ikalainen

Allen J. Ikalainen, P.E.
Site Manager
E.C. Jordan Co.

Approved by:

Siegfried L. Stockinger, P.E.
Project Manager
Ebasco Services Incorporated

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1.0 INTRODUCTION

New Bedford Harbor is a tidal estuary located between the City of New Bedford and the Town of Fairhaven at the Head of Buzzards Bay, Massachusetts, as shown in Figure 1. The harbor sediment contains elevated levels of polychlorinated biphenyls (PCBs) and heavy metals.

This report presents results of a preliminary geotechnical investigation conducted at the New Bedford Harbor Superfund site in Bristol County, Massachusetts. The information obtained from this investigation will be used in the evaluation of the engineering feasibility of various remediation alternatives considered for this site. This work has been funded by the United States Environmental Protection Agency (EPA) under REM III Contract No. 68-01-7250 to Ebasco Services, Inc. (Ebasco).

The report contains four main sections as follows:

- Section 1, Introduction
- Section 2, Subsurface Investigation
- Section 3, Geotechnical Laboratory Investigation
- Section 4, Subsurface Conditions

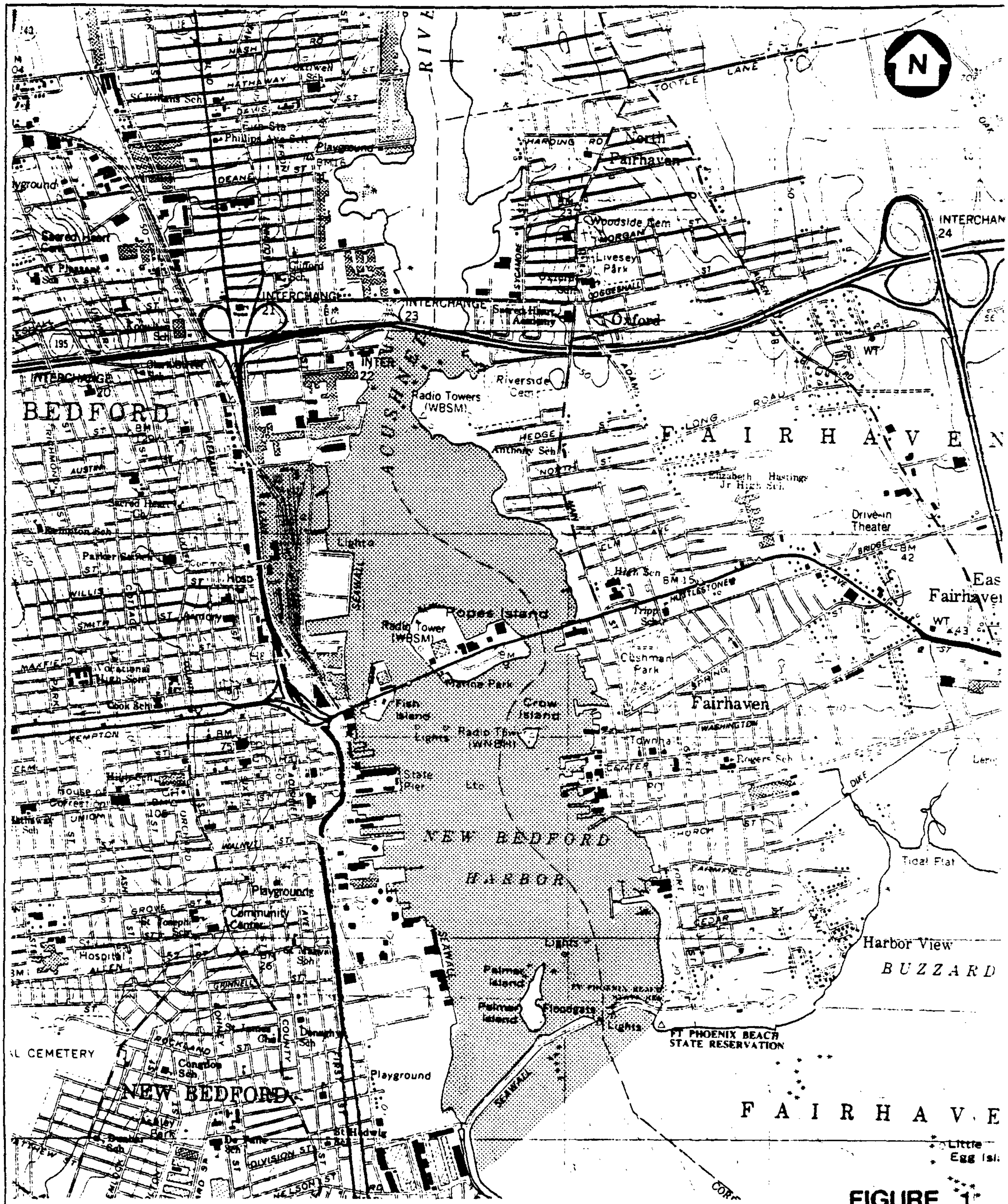

FIGURE 1
SITE VICINITY MAP
PRELIMINARY GEOTECHNICAL INVESTIGATION
OF ENGINEERING PROPERTIES
NEW BEDFORD HARBOR SUPERFUND SITE
BRISTOL COUNTY, MASSACHUSETTS

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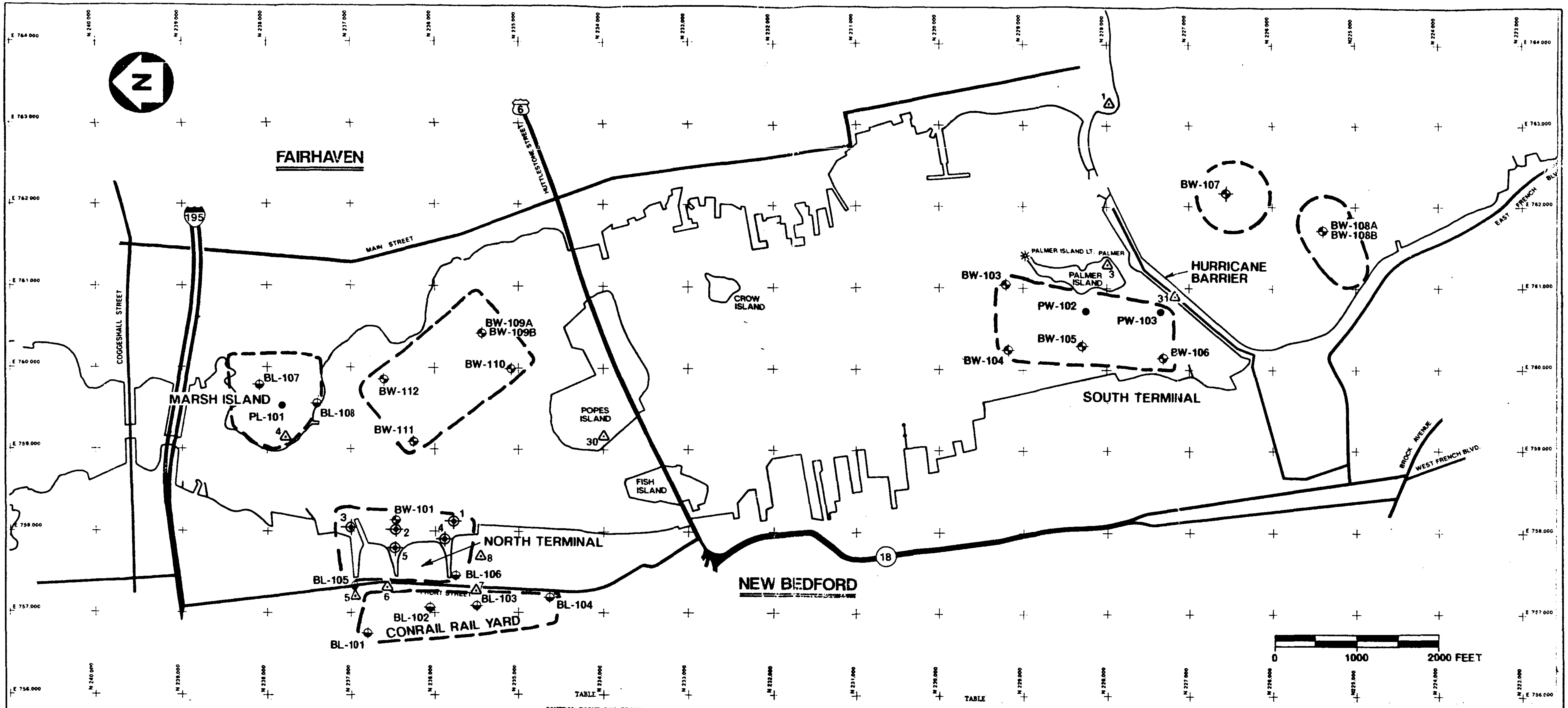

LEGEND

⊕ BW	OFFSHORE BORING
⊕ BL	LAND BORING
● PW	OFFSHORE PROBE
● PL	LAND PROBE
⊕ 1	OFFSHORE BORING (BY GZA, 3/85)
(- -)	APPROXIMATE BOUNDARY OF POSSIBLE DISPOSAL OR CONTAINMENT AREA
1△	HORIZONTAL CONTROL POINTS

TABLE

CONTROL POINT LOCATIONS

Traverse Control Point	Description	Northing	Easting	Elevation
1	MK-1 CGS Brass Disk, Fort Phoenix	227965.4900	763254.4900	
3	Brass Plug, Palmer Island	227981.0000	761320.6300	
4	MK-6 Brass Plug, Marsh Island	237717.6400	759140.5200	23.30
5	Conc. Mon. w/Brass Pin	236896.6605	757260.6409	6.26
6	1/2" Rebar	236509.2661	757349.9626	6.78
7	1/2" Rebar	235505.6821	757316.1505	8.56
8	3/4" Rebar	235429.6892	757696.7135	7.58
30	Top Center Light, Radio Tower, Pope Island	233947.9217	759162.3730	
31	Brass Disk On Hurricane Barrier	227153.5132	760907.0395	20.07

TABLE

EXPLORATION LOCATIONS

Well, Boring, or Sampling Point	Northing	Easting	Elevations		
			Ground	Top of Casing	Top of PVC
BL-101	236759.2808	756767.0607	7.9	10.58	10.44
BL-102	236030.9873	757082.2986	7.4	9.58	9.16
BL-103	235481.8877	757107.0344	7.1	10.09	9.90
BL-104	234619.0129	757208.4146	5.7	7.87	7.73
BL-105	236924.4059	757455.9587	5.9	5.94	5.78
BL-106	235731.6723	757473.7759	8.2		
BL-107	238055.2731	759796.2884	6.3	8.30	8.06
BL-108	237372.3736	759566.1399	6.3		
BW-101	236431.0506	758147.6911	-9.4		
BW-103	229213.7482	761049.8375	-8.4		
BW-104	229185.0109	760252.0874	-6.0		
BW-105	228299.9997	760300.0004	-6.2		
BW-106	227339.7738	760160.1933	-3.0		
BW-107	226530.0	762170.0			
BW-108	225409.6717	761717.5141	-11.4		
BW-109	235423.1302	760428.6757			
BW-110	235074.1742	759998.5656			
BW-111	236217.2771	759102.1320	-5.7		
BW-112	236565.5655	759866.1994			
PL-101	237781,3249	759540.1314	9.1		
PW-102	228258.3329	760727.0680	-9.1		
PW-103	227352.4405	760718.6961	-4.9		

FIGURE 2
EXPLORATION PLAN
PRELIMINARY GEOTECHNICAL INVESTIGATION OF ENGINEERING PROPERTIES
NEW BEDFORD HARBOR SUPERFUND SITE
BRISTOL COUNTY, MASSACHUSETTS

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- o Area slightly south of the hurricane barrier as designated by boring BW-107

- o Area south of the hurricane barrier as designated by borings BW-108A and BW-108B

The North Terminal Area is within the offshore and onshore zones. The North Terminal area is a commercial development with parking lots (predominantly stone and gravel), shipping docks, wharfs, warehouses, manufacturing plants, and various other buildings.

Marsh Island, an abandoned spoils site, and presently the location of three radio transmission towers, is within the onshore zone. Ground cover is predominantly marsh grasses with additional brush and small trees scattered about.

The Conrail Rail Yard is located in a peripheral upland zone. At one time the rail yard was used for the transfer, loading, and storage of raw materials, manufactured goods, etc. At present, rail spurs, abandoned buildings, rail relics, and miscellaneous refuse (e.g., used paper and plastic products, abandoned cars, used machinery parts, etc.) are scattered on site. Additionally, the area is moderately vegetated with grasses, brush, and small trees.

1.2 PROJECT DESCRIPTION

The New Bedford Harbor Superfund site includes the lower and upper harbor, and a portion of Buzzards Bay. The EPA has authorized a work assignment (Work Assignment No. 04-1L43) to perform a Remedial Investigation/Feasibility Study (RI/FS) for the site. The objective of the preliminary geotechnical investigation is to provide information to evaluate the engineering feasibility of several remediation alternatives. These alternatives are as follows:

- disposal (e.g., confined aquatic disposal, etc.)
- removal (e.g., dredging, etc.)
- containment (e.g., earthen dikes, double sheet pile walls, etc.)

The preliminary geotechnical investigation accomplished this objective at seven areas within the harbor site (see Section 1.1, Site Description) through the execution of the following activities:

- A total of 24 explorations were drilled including 13 borings and 2 probes offshore; and 8 borings and 1 probe on land, at locations shown in Figure 2. All drilling activities were completed in accordance with ASTM D420 and OSHA modified level D personal protection.

- Soil and rock samples were obtained from the boring explorations using a standard split-spoon sampler, 2-inch and 3-inch thin-walled tube samplers, and a single and double barrel rock core sampler.
- Piezometers were installed to measure groundwater levels in six of the land borings.
- Field vane shear tests (FVST) were conducted to determine variations in shear strength within the surficial cohesive soils (organic silt).
- Field drilling, sampling, and testing were monitored and documented full time by qualified Jordan engineers and geologists.
- All explorations were surveyed for location and elevation using survey control points established by Diversified Technologies Corporation under EPA Work Assignment No. 04-1L43 (see Final Field Survey Location Control Report, New Bedford, Massachusetts, DTC August 23, 1988).

- Soil samples were screened for PCB concentrations prior to physical laboratory testing.

- Physical laboratory tests were performed on selected soil samples to better define the classification and engineering properties of the subsurface soils.

2.0 SUBSURFACE INVESTIGATION

Subsurface explorations made for the preliminary geotechnical investigation were performed to establish thicknesses, classification, and engineering properties of the various soil strata, and to determine bedrock depths. In January and February 1988, 21 borings and three probes were drilled by GZA Drilling, Inc. of Canton, Massachusetts, within the harbor area at locations shown in Figure 2. The borings were monitored on a full time basis by Jordan engineers and geologists. EPA dermal Level C personal protective equipment was used. Horizontal and vertical locations of each exploration were surveyed by Diversified Technologies Corp. (DTC) of North Haven, Connecticut. Horizontal and vertical control was previously established by the USACE. Horizontal location control for the explorations are referenced according to the 1,000-foot grid system superimposed in Figure 2.

Explorations were conducted offshore using a barge-mounted Acker skid rig, and on land (onshore and peripheral upland areas) using a truck rig. Thirteen offshore borings included BW-101, BW-103 through BW-107, BW-108A, BW-108B (BW-108B was drilled because a boulder was encountered in BW-108A), BW-109A, BW-109B (BW-109B was drilled to obtain 3-inch thin-wall tube samples that could not be obtained in BW-109A), and BW-110 through BW-112. Eight land borings included BL-101 through BW-108 with piezometers installed in each one except BL-106 and BL-108. The probes included two offshore, and one on land; PW-102 and PW-103, and PL-101; respectively. Jordan's on-site exploration monitoring included the following:

- o All exploratory drilling, soil and rock sampling, and piezometer installations were continuously observed by qualified engineers or geologists.

- o Explorations were logged in the field with samples classified according to procedures outlined in ASTM D2488. The logging and classifying of soil and rock samples were recorded on a Soil Boring Log and a Rock Core Identification Log, respectively.

- o A complete and accurate field log was maintained for each exploration, including project name, exploration number, rig type, drilling company, driller's name, name of Jordan field personnel, casing size and type, water depth when applicable, sample number and depth, Standard Penetration Test (SPT) N-values, casing or probe rod blows per foot of penetration, and soil or rock classification and description.

- o A field notebook was maintained by Jordan personnel at each drill rig. The notebook was a standard bound survey book. Entries included dates, weather conditions, personnel and drillers, level of personal protection used, and any pertinent observation deemed necessary to document.

- Prior to leaving the site each day, chain-of-custody record forms were completed for each sample by Jordan field personnel.

- The samples were stored in coolers filled with cushioning material to deter adverse movement during shipment, and to prevent freezing.

- All documentation required to accompany the samples during shipment was kept in a sealed plastic bag and placed into the cooler. All soil and rock samples shipped to the soils laboratory for geotechnical testing were accompanied with a geotechnical laboratory Hazardous Material (HAZ/MAT) sample tracking form, and a chain-of-custody record form. An analysis request form and chain-of-custody record form were sent with all soil samples shipped to the analytical laboratory for PCB screening.

To summarize information recorded in the field, engineering logs were prepared and are presented in Appendix A. These logs describe the soil coloration, texture, consistency, and other pertinent information in accordance with ASTM D2488. Additional information recorded on the logs includes depth and type of samples, laboratory test designations, measured water contents, and FVSTs (rock core, and piezometer data when applicable). A key to the descriptions, symbols, and terms used in the engineering logs is presented on Sheet A-2 in Appendix A.

Five additional explorations were drilled in the North Terminal area prior to Jordan's preliminary geotechnical investigation. Borings 1, 2, 3, 4, and 5 were drilled by GZA Drilling, Inc. of Canton, Massachusetts in the winter of 1985. Locations are shown in Figure 2. Boring logs for these five explorations are included in Appendix A.

2.1 DRILLING AND SAMPLING

Twenty-one borings and three probes were drilled in January and February 1988. The exploration program consisted of the following:

- <u>Offshore Explorations</u>
    - Six 3-inch cased borings plus rock core
    - Three 3-inch cased borings

  - Two 4-inch cased borings plus rock core
  - Two 4-inch cased borings
  - Two BW rod probes

- o <u>Land</u>

  - Six 3-inch cased borings plus rock core
  - Two 3-inch cased borings
  - Piezometers installed in six borings
  - One BW rod probe

A summary of pertinent exploration data is presented in Table 1.

Borings were advanced in accordance with the general procedures of ASTM D1586 to refusal, or in the case of BW-109B, end of exploration. Refusal was generally defined as 100 blows with no penetration during a standard penetration test (SPT). Selected borings, indicated in Table 1, obtained a B or N size rock core to determine if the refusal surface was bedrock. Borings were advanced using threaded flush joint 3- or 4-inch inside diameter (ID) casing; and jet water, and wash rotary drilling techniques for the offshore and land borings; respectively. Advancement of the casing was accomplished using a 300-pound drive hammer with an 18-inch drop. The number of blows required to advance the casing each foot was recorded. Whenever exceedingly hard drilling was encountered, such as very dense till or boulders, systematic

TABLE 1

SUMMARY OF ENGINEERING LOGS

Exploration Designation	Date of Exploration	Lambert Grid Coordinates		Surface Elev. (MSL,ft.)	Refusal		Rock Core		Piezometer	
		Northing	Easting		Depth (feet)	Elev. (MSL,ft.)	Length Rec. (feet)	RQD (%)	Depth to Slotted Pipe Midpoint (feet)	Water Level 2/18/88 @ Time (MSL,ft.)
BW-101	1/22-1/26/88	236,431.1	758,147.7	-9.4	39.0	-48.4	4.0 2.75	59.0		
BW-103	1/15/88	229,213.7	761,049.8	-8.4	25.5	-33.5				
BW-104	1/13-1/14/88	229,185.0	760,252.1	-6.0	32.8	-38.8				
BW-105	1/8/88	228,300.0	760,300.0	-6.2	14.5	-20.5				
BW-106	1/19/88	227,339.8	760,160.5	-3.0	21.7	-24.7	5.0 5.0	59.0		
BW-107	2/11/88	226,530.0	762,170.0	-17.2	28.7	-45.9	3.5 3.25	87.7		
BW-108A	1/21/88	225,409.7	761,717.5	-11.4	5.0	-16.4				
BW-108B	1/21/88	225,409.7	761,717.5	-11.4	8.0	-19.4				
BW-109A	2/4-2/9/88	235,423.1	760,428.7	-8.9	42.8	-51.7	5.3 2.5	12.3		
BW-109B	2/9/88	235,423.1	760,428.7	-8.9	No Refusal					
BW-110	2/9-2/10/88	235,074.2	759,998.6	-10.3	62.0	-70.3				
BW-111	1/28-2/3/88	236,217.3	759,102.1	-5.7	73.0	-78.7	1.75 1.3	0.0		
BW-112	2/3/88	236,565.6	759,866.2	-6.3	42.8	-49.1				
PW-102	1/13/88	228,258.3	760,727.1	-9.1	20.4	-29.4				
PW-103	1/20/88	227,362.4	760,718.7	-4.9	20.6	-25.5				

TABLE 1 (Continued)

SUMMARY OF ENGINEERING LOGS

Exploration Designation	Date of Exploration	Lambert Grid Coordinates		Surface Elev. (MSL,ft.)	Refusal		Rock Core		Piezometer	
		Northing	Easting		Depth (feet)	Elev. (MSL,ft.)	Length Rec. (feet)	RQD (%)	Depth to Slotted Pipe Midpoint (feet)	Water Level 2/18/88 @ Time (MSL,ft.)
BL-101	1/18/88	236,759.3	756,767.1	7.9	23.3	-15.4	5.0 4.8	72.0	19.5	4.7/11:45
BL-102	1/22/88	236,031.0	757,082.3	7.4	6.3	1.1	5.0 4.9	98.0	4.7	4.5/11:55
							5.0 4.2	84.0		
BL-103	1/19-1/20/88	235,481.9	757,107.0	7.1	52.3	-45.2	5.0 4.9	98.0	19.5	4.0/12:05
BL-104	1/21-1/22/88	234,619.0	757,208.4	5.7	35.7	-30.4			10.5	3.9/12:15
BL-105	1/12-1/13/88	236,924.4	757,456.0	5.9	36.0	-30.1	5.2 4.6	88.5	32.5	1.9/11:40
BL-106	1/7-1/11/88	235,731.7	757,473.8	8.2	45.7	-37.5	5.2 5.0	96.2		
BL-107	1/26-1/28/88	238,055.3	759,796.3	6.3	53.6	-47.3	2.4 2.0	41.7	10.5	3.7/10:01
BL-108	1/25-1/26/88	237,372.4	759,566.1	6.3	44.6	-38.3				
PL-101	1/28/88	237,781.3	759,540.1	9.1	52.9	-43.8				

spinning of casing with a cutting shoe, or core drilling of boulders with telescoping techniques, was required to advance the boring. Borehole cuttings and drilling fluid were in the borehole. Land borings were drilled predominantly with cased borings but at times with hollow-stem auger drilling techniques, at the discretion of Jordan's field personnel. Hollow-stem auger techniques were generally used provided sands were not flowing into the bottom of the auger and if cold weather prevented the circulation of wash water.

Soil probes were made at two offshore locations (PW-102 and PW-103), and one land location (PL-101) using BW rods equipped with a hollow-stem tip for the offshore probes, and a hardened drive point for the land probe. The probes were advanced to refusal with a 140-pound drive hammer falling 30 inches, except where specifically noted on the engineering logs. The number of blows required to advance the rod probe each foot was recorded. Probe refusal was defined as 100 blows with no penetration.

Soil samples were obtained using a 2-inch outside diameter (OD) split-spoon sampler and/or a 2- or 3-inch thin-wall tube sampler. Samples were obtained continuously at each boring location from 2 feet to approximately 16 feet, and at 5-foot intervals from 16 feet to refusal. Exceptions to this procedure occurred when cohesive soils were encountered (cohesive soils were continuously sampled). Other exceptions are noted on the engineering logs.

The 2-inch OD split-spoon sampler was 24 inches in length and equipped with a check ball head. A 140-pound drive hammer falling 30 inches advanced the split-spoon sampler, in accordance with SPT procedures outlined in ASTM D1586. Sampler driving resistance for each 6-inch interval was recorded; however, only the SPT N-value in blows per foot is presented on the engineering logs. Refusal driving resistance was generally defined as 100 blows with no penetration. Most samples were driven 24 inches into the soil with water levels in the casing filled to prevent soil heave into the bottom of the casing. All split-spoon soil samples were extruded from the sampler, classified, logged (as discussed previously), and placed in 16-ounce sample jars for subsequent laboratory physical testing.

Open 2- or 3-inch thin-wall tubes, 30 inches in length, were used to obtain "undisturbed" soil samples. The tubes were pushed 24 inches into undisturbed soil via weight of drilling rods. Sampling was performed in accordance with procedures outlined in ASTM D1587.

Soil samples taken at depths less than 6 feet were placed in a laboratory-prepared 16-ounce glass jar for subsequent analytical screening for PCBs, as discussed in Section 3.0, Geotechnical Laboratory Investigation.

Rock core samples were obtained and stored in accordance with ASTM D2113. Double-barrel, N-size core sampling was expressly used except where telescope drilling techniques had to be incorporated in order to continue advancement of the borehole. Then, a single-barrel core was used.

The truck rig and its drilling equipment were decontaminated with a steam cleaning device between each land boring and at the end of each working day. The offshore rig (barge) and all its equipment were decontaminated at the beginning and end of the field program, or when the barge was docked. Barge decontamination was accomplished using a jet water wash and scrub brushes when necessary.

2.2 FIELD VANE SHEAR TESTING

FVSTs were conducted at 2-foot depth intervals at five offshore boring locations, BW-101, BW-108A, BW-109A, BW-110, and BW-112, to evaluate the undrained shear strength characteristics of the organic silt soils. The FVSTs were conducted adjacent to (within 10 feet) each boring listed previously. The vane, on loan from USACE-NED, was a four-inch by eight-inch stainless steel vane attached to 1-inch diameter steel piping.

The testing was conducted using the torque wrench method as outlined in ASTM D2573. After the vane was pushed to the desired depth and held stationary for at least one minute, torque was applied to the vane with an inch-pound calibrated torque wrench. The vane was rotated at a rate of approximately 1 revolution per 5 minutes. After a peak torque reading was obtained, the vane was rotated quickly three times at a rate of approximately 20 revolutions per minute, then pushed to the next depth interval. A tabulation of the undrained shear strengths for peak and residual values at each of the five boring locations is presented on the corresponding logs in Appendix A and summarized in Table 2.

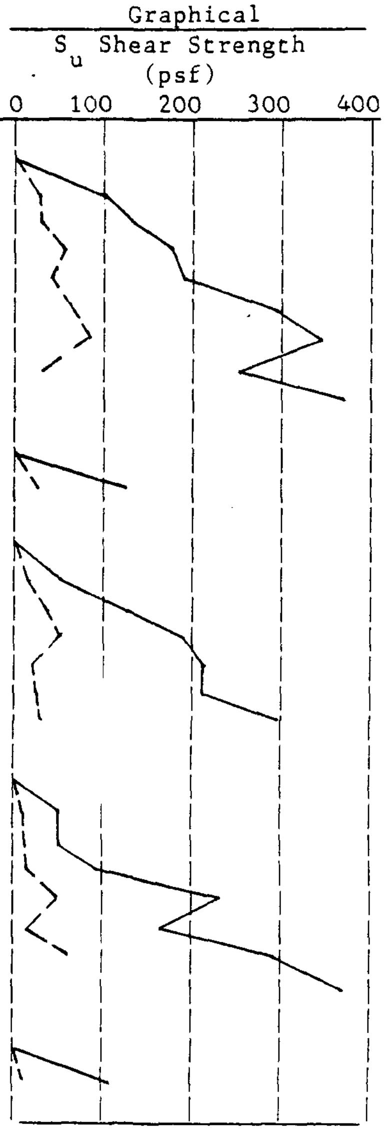
2.3 PIEZOMETER INSTALLATION AND GROUNDWATER MEASUREMENTS

Piezometers were installed in borings BL-101 through BL-105, and BL-107 in order to measure groundwater levels. Each piezometer consisted of 1-inch ID Schedule 40 PVC flush-jointed pipe connected to the piezometer tip consisting of a 5-foot section of 0.010-inch slotted pipe. The slotted section was placed at depths indicated on the engineering logs. Bentonite pellet seals were inserted at locations (established by Jordan field personnel) shown on the logs. The annular space between the bottom of the boring and the bentonite seal was backfilled with filter sand. The remaining portion of the borehole was backfilled with soil cuttings from the drilling operation. All piezometers, except in

TABLE 2

SUMMARY OF FIELD VANE SHEAR TESTS (FVSTs)

Probe Number	Surface Elevation (MSL)	Depth (feet)	S_u Shear Strength (psf) Residual	S_u Shear Strength (psf) Peak
BW-101		0.0	0	0
		1.0	25	98.2
		3.0	31	129
		5.0	49	172
		7.0	40	187
		9.0	61	295
		11.0	83	338
		13.0	31	249
		15.0	NA	368+
BW-108A		0.0	0	0
		1.0	25	123
BW-109A		0.0	0	0
		1.0	15	49
		3.0	37	122
		5.0	52	184
		7.0	21	203
		9.0	25	209
		11.0	31	295
BW-110		0.0	0	0
		2.0	12	52
		4.0	12	52
		6.0	18	92
		8.0	43	221
		10.0	18	166
		12.0	61	295
		14.0	NA	368+
BW-112		0.0	0	0
		1.0	15	110



boring BL-105, had 2 to 3 feet stick-up above ground, protected with 3-inch capped PVC casing. The piezometer in boring BL-105 was completed using flush-to-the-ground protective road box cemented in place. Water levels measured in the piezometers are presented in Table 3.

TABLE 3

PIEZOMETER DATA

Piezometer Location	Ground Surface Elevation (MSL,ft.)	Water Elevation (MSL,ft.) 2-18-88 @ Time
BL-101	7.9	4.7 @ 11:45 a.m.
BL-102	7.4	4.5 @ 11:55 a.m.
BL-103	7.1	4.0 @ 12:05 p.m.
BL-104	5.7	3.9 @ 12:15 p.m.
BL-105	5.9	1.9 @ 11:40 a.m.
BL-107	6.3	3.7 @ 10:01 a.m.

3.0 GEOTECHNICAL LABORATORY TESTING

Geotechnical laboratory tests were conducted on selected soil samples to better define the physical properties of the subsurface soils. The first and second sample (sample depths of 2 to 4 feet and 4 to 6 feet) obtained from the geotechnical borings were screened for PCB content to verify the concentration in parts per million (ppm). Geotechnical laboratory testing was performed on samples from borings where the first and second, and the third if required, sample concentrations were less than 1.0 ppm. Modified OSHA Level C (i.e., Level C dermal, and when appropriate Level C respiratory) personal protective equipment was used to conduct all geotechnical laboratory testing. The laboratory tests were performed in accordance with the American Society of Testing and Materials (ASTM) procedures or with procedures described in the USACE Manual of Laboratory Testing, EM 1110-2-1906 (USACE EM).

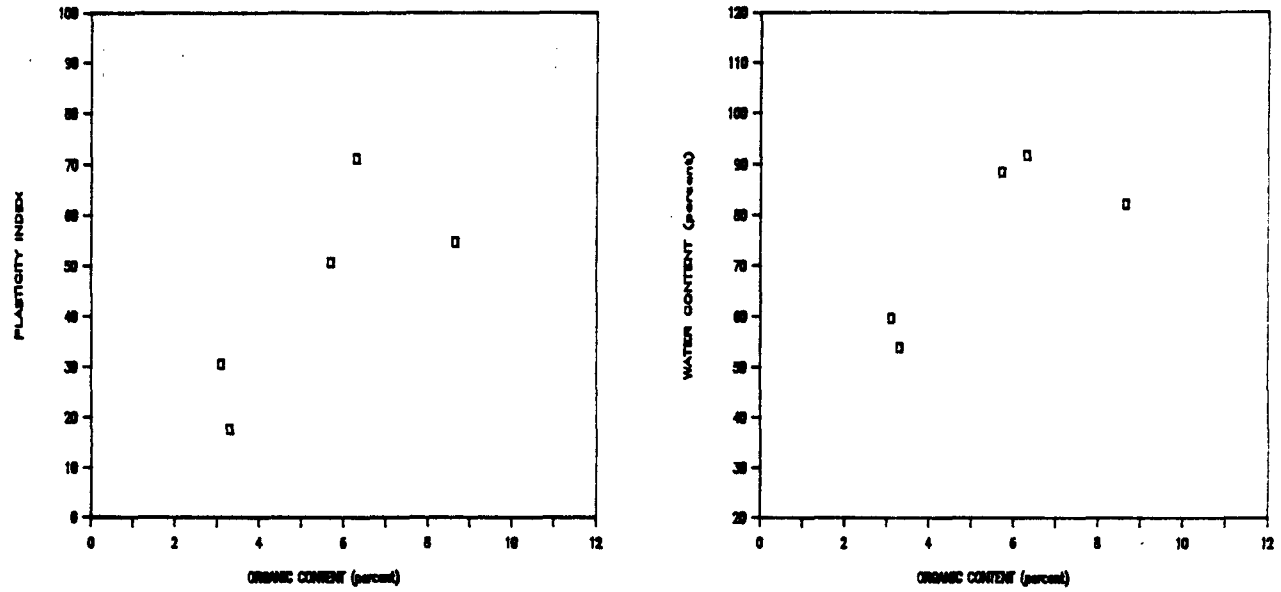
Laboratory testing, including classification and engineering properties tests, was conducted at Jordan's geotechnical laboratory located in Portland, Maine. Classification tests were made for identification and correlation purposes, and included water content, organic content, mechanical and hydrometer gradation analyses, Atterberg limits, and specific gravity. Engineering properties tests were conducted to determine shear strength parameters, and included direct shear tests, a consolidated undrained (Cu) triaxial compression test, and laboratory torque vane shear tests. The number and type of geotechnical tests conducted are summarized in Table 4. A short discussion concerning soil characteristics (organic silt and granular soil) based on laboratory test results and field vane shear testing is presented in subsequent subsections.

3.1 CLASSIFICATION PROPERTIES

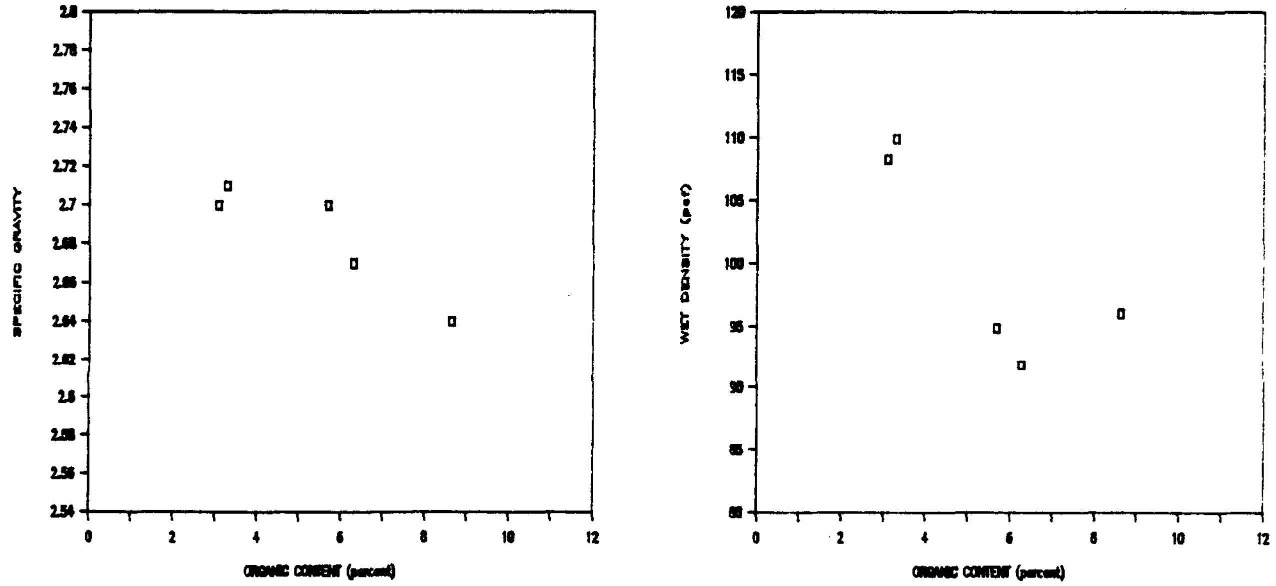
Classification property tests were conducted for identification and correlation purposes for both the granular and organic silt soils. Six different tests were part of the overall geotechnical laboratory testing program:

- <u>Water Content</u> - A total of 66 water content determinations were made on "representative" soil samples. All tests were conducted in accordance with ASTM D2216. Water contents are tabulated in Table 4 and recorded on the engineering logs. A graphical plot of organic content versus water content is presented in Figure 3b.

- <u>Organic Content</u> - Organic contents were determined for six soil samples in accordance with ASTM D2974. Organic contents are tabulated in Table 4 and plotted in each of the graphical plots in Figure 3.



(a) ORGANIC CONTENT VERSUS PLASTICITY INDEX (b) ORGANIC CONTENT VERSUS WATER CONTENT



(c) ORGANIC CONTENT VERSUS SPECIFIC GRAVITY (d) ORGANIC CONTENT VERSUS WET DENSITY

FIGURE 3
ORGANIC SILT CHARACTERISTICS - CLASSIFICATION PROPERTIES
PRELIMINARY GEOTECHNICAL INVESTIGATION
OF ENGINEERING PROPERTIES
NEW BEDFORD HARBOR SUPERFUND SITE
BRISTOL COUNTY, MASSACHUSETTS

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- Grain Size Analyses - Grain size analyses were performed in 44 soil samples according to procedures outlined in ASTM D421 and D422. Five samples (U-3 and U-4, U-1, and C-1 and C-2 from borings BW-101, BW-106, and BW-110, respectively) had both the mechanical and hydrometer gradation analyses. All other samples were analyzed using only the mechanical gradation analysis. Grain size distribution curves are presented in Appendix B.

- Atterberg Limits - Atterberg limits were determined for soil samples U-3 and U-4, U-1, and C-1 and C-2 from borings BW-101, BW-106, and BW-110, respectively. Laboratory procedures are outlined in ASTM D4318. Results are recorded in Table 4 and presented on Figure 4 (Plasticity Chart). Additional information is located in Appendix C.

- Specific Gravity - Specific gravity tests were established for the same soil samples previously listed in Item 4 in accordance with procedures outlined in ASTM D854. Test values are presented in Table 4 and graphically plotted against organic content on Figure 3c.

- Wet Density - Wet densities, listed in Table 4, were determined from weight and volume measurements from

TABLE 4
SUMMARY OF LABORATORY DATA

			CLASSIFICATION PROPERTIES									ENGINEERING PROPERTIES							
												SHEAR STRENGTH PARAMETERS							
												DIRECT SHEAR		LABORATORY VANE SHEAR			STAGED TRIAXIAL		
				ATTERBERG LIMITS															
BORING NUMBER	SAMPLE NUMBER	SAMPLE DEPTH (FT.)	WATER CONTENT, W_c	LIQUID LIMIT	PLASTIC LIMIT	ORGANIC CONTENT, O_c	SPECIFIC GRAVITY, G_s	WET DENSITY, γ_w, psf	CALCULATED VOID RATIO, e_o (1)	GRAIN SIZE DATA FIGURE		DIRECT SHEAR DATA FIGURE	INTERNAL FRICTION ANGLE ϕ	TOP OF TUBE MEASUREMENT, psf	MIDDLE OF TUBE MEASUREMENT, psf	BOTTOM OF TUBE MEASUREMENT, psf	STAGED TRIAXIAL DATA FIGURE	INTERNAL FRICTION ANGLE ϕ	
BW-101	U-1	2-4	52.1							B-2									
	U-3	6-8	91.5			6.2													
			91.8	112.5	41.3	6.3	2.67	94.3	2.39	B-2				NA	NA	123/20			
			86.4																
	U-4	12-14	75.1																
			54.0	42.0	24.3	3.3	2.71	109.9	1.37	B-2				NA	41/10	NA	E-1	30.0	
			36.8																
			36.7																
	S-6	23-25	17.7							B-2									
BW-103	S-6	12-14	59.2							B-3									
	S-10	23-25	10.5							B-3									
BW-104	S-5	10-12	19.1							B-4									
	S-7	14-16	18.1							B-4									
	S-9	25-27	11.1							B-4									
BW-105	S-2	4.5-6.5	12.1							B-5									
BW-106	U-1	6-8	63.6																
			65.8																
			82.2	102.2	47.5	8.65	2.64	96.1	2.12	B-6				NA	338/45	338/40			
			98.8																
	S-6	14-16	11.4							B-6									
	S-7	19-21	8.3							B-6									
BW-107	S-6	12-14	43.0							B-7		D-2	31.0						
BW-108A	S-1	2-4	7.3							B-8									
BW-108B	S-1	4-6	10.2							B-8									
BW-109A	S-2	4-6	114.9							B-9									
	S-7	14-16	12.5																
BW-110	U-1	2-4	88.5	85.2	34.4	5.7	2.70	94.9	2.35	B-10									
			76.7																
			87.3																
	U-2	6-8	85.6																
			59.7	57.0	26.4	3.1	2.70	108.3	1.48	B-10									
			52.0																
	U-4	14-16	14.0							B-10									
	S-9	34-36	10.9							B-10									
BW-111	S-1	2-4	18.0							B-11									
	S-3	6-8	33.7							B-11		D-3	33.0						
	S-11	33-35	18.6							B-11									
	S-14	48-50	29.6							B-11									
BW-112	S-1	2-4	38.0							B-12									
	S-3	6-8	22.6							B-12									
	S-8	19-21	17.9							B-12									
	S-10	28-30	17.6							B-12									
BL-101	S-6	12-14	6.1							B-13									
BL-103	S-2	4-6	11.0							B-14									
	S-7	14-16	16.9							B-14									
BL-104	S-3	6-8	22.3							B-15									
	S-8	20-22	14.1							B-15									
BL-105	S-3	6-8	21.4							B-16									
BL-106	S-3	6-8	39.0							B-17									
	S-7	14-16	34.1							B-17									
BL-107	S-6	12-14	39.5							B-18									
	S-8	20-22	18.2							B-18		D-4	32.0						

TABLE 4
SUMMARY OF LABORATORY DATA

			CLASSIFICATION PROPERTIES									ENGINEERING PROPERTIES SHEAR STRENGTH PARAMETERS							
				ATTERBERG LIMITS								DIRECT SHEAR		LABORATORY VANE SHEAR			STAGED TRIAXIAL		
BORING NUMBER	SAMPLE NUMBER	SAMPLE DEPTH (FT.)	WATER CONTENT, W_c	LIQUID LIMIT	PLASTIC LIMIT	ORGANIC CONTENT, O_c	SPECIFIC GRAVITY, G_s	WET DENSITY, γ_w, psf	CALCULATED VOID RATIO, e_o (1)	GRAIN SIZE DATA FIGURE		DIRECT SHEAR DATA FIGURE	INTERNAL FRICTION ANGLE φ	TOP OF TUBE MEASUREMENT, psf	MIDDLE OF TUBE MEASUREMENT, psf	BOTTOM OF TUBE MEASUREMENT, psf	STAGED TRIAXIAL DATA FIGURE	INTERNAL FRICTION ANGLE φ	
BL-108	S-1	2-4	19.6							B-19									
	S-4	8-10	22.6							B-19									
	S-7	14-16	31.0							B-19		D-5	34.0						
	S-9	25-27	15.3							B-19									

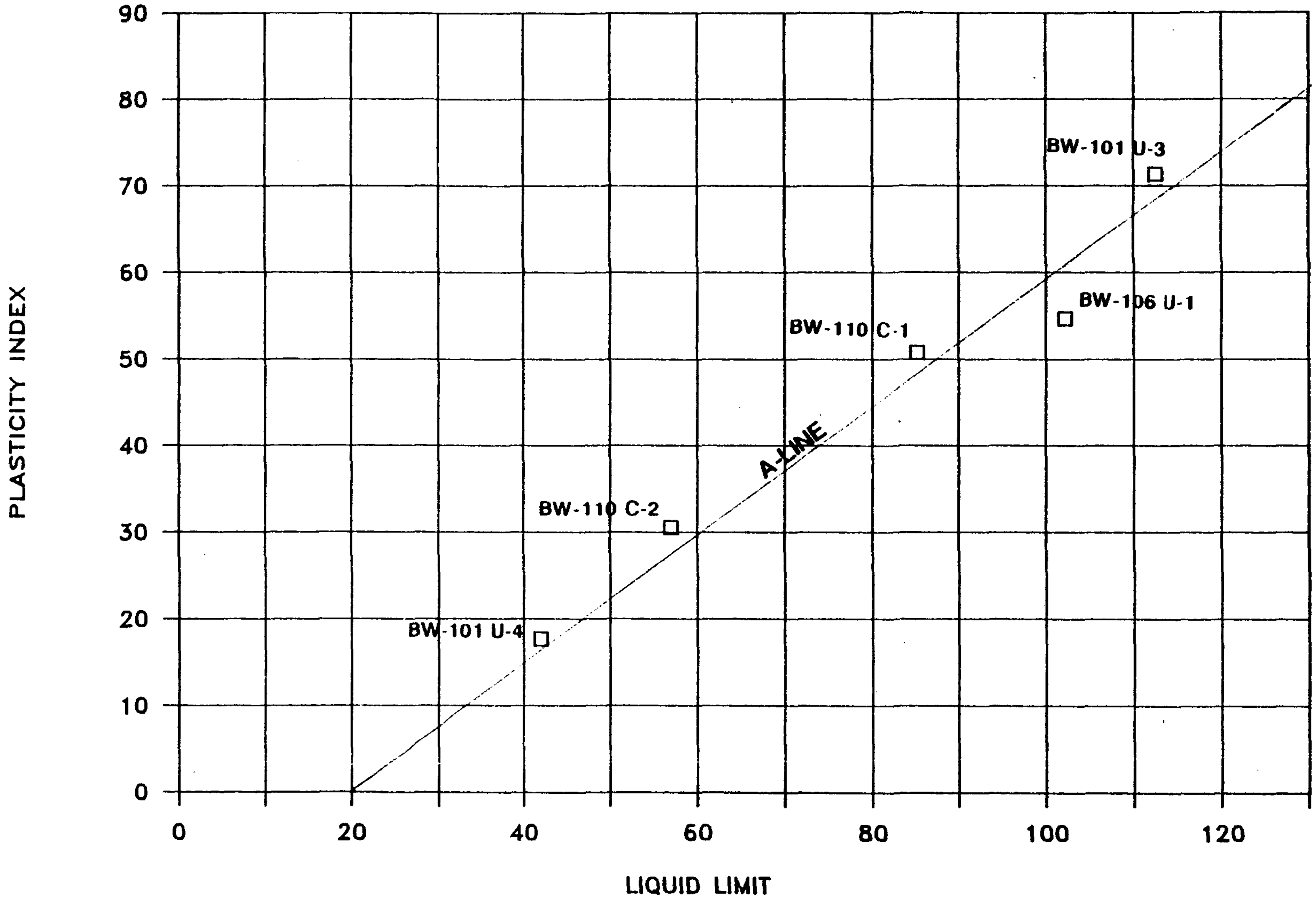

FIGURE 4
PLASTICITY CHART
PRELIMINARY GEOTECHNICAL INVESTIGATION
OF ENGINEERING PROPERTIES
NEW BEDFORD HARBOR SUPERFUND SITE
BRISTOL COUNTY, MASSACHUSETTS

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thin-wall tube samples. Volume was determined by measuring the length of the extruded sample then multiplying this value with the assumed constant sample diameter equal to the inside diameter of the tube. A graphical plot of organic content versus wet density is shown on Figure 3d.

The granular soils were correlated to one another through mechanical gradation analysis. The gradation curves are presented in Appendix B.

Correlations between the classification tests for the organic silt soils were done in several ways: (1) gradation curves (presented in Appendix B); and (2) graphical plots of organic content versus plasticity index, water content, specific gravity, and wet density, as shown on Figure 3(a-d), respectively. Organic content is the common element in each of the correlations presented in Figure 3 and was selected due to laboratory-testing ease and the seemingly good correlation with the respective data. Site-specific correlations involving organic content can be readily summarized. As the organic content of the silty soil increases, the following are generally assumed:

- increased plasticity
- increased water content

- decreased specific gravity

- decreased wet density

3.2 ENGINEERING PROPERTIES

Three types of engineering properties tests were conducted to determine shear strength parameters.

- <u>Direct Shear Tests</u> - Direct shear tests were completed on four granular soil samples (S-6, S-3, S-6, and S-8 from borings BW-107, BW-111, BL-107, and BL-108) in accordance with procedures outlined in ASTM D3080. The samples had varying gradations and textures ranging from silty to coarse sandy-size particles. A total of three points, corresponding to normal stresses of approximately 500, 1,000, and 1,500 psf, were determined for each of the soil samples. Results of the direct shear tests are presented in Table 5. Additional data for the direct shear tests are in Appendix D.

- <u>Consolidated Undrained Staged Triaxial Compression (Cu) Tests</u> - One staged Cu test, conducted at three successively increasing consolidation pressures, was performed on undisturbed tube sample U-4 taken from

TABLE 5

SUMMARY OF INTERNAL FRICTION ANGLES

Boring No.	Sample No.	Description	Effective Internal Friction Angle ϕ'
BW-107	S-6	ML tannish very fine sandy silt	31
BW-111	S-3	SP-SM brown fine sand, trace silt	33
BL-107	S-6	SP olive fine sand, trace silt	32
BL-108	S-7	SP olive fine to medium sand, trace coarse sand	34
BW-101	U-4	OL dark gray sandy organic silt, trace gravel	30 (with C=140 psf)

boring BW-101. The staged test results were used to develop an effective stress envelope, which in turn yields an effective internal friction angle. The test specimen was extruded from tube U-4, trimmed to approximately 6 inches in length, and placed in the triaxial cell. Staged testing was conducted in accordance with procedures described by USACE EM, Appendix X. The sample was loaded at a strain rate of 0.006 inch per minute with effective stress paths plotted as the test proceeded so that loading could be stopped prior to ultimate failure at the first two consolidation pressures. Results of the staged Cu test are shown in Table 5, with additional information presented in Appendix E.

- <u>Laboratory Torque Vane Shear Tests</u> - Laboratory vane tests were conducted with a GEONOR vane on tube samples U-3 and U-4 from boring BW-101, and U-1 from boring BW-106. A summary of the laboratory torque vane testing results is presented in Table 6. The data, although not extensive, is similar in magnitude and appears to reflect the general trend with depth of FVST values. The lower portion of Figure 5 illustrates the trend of increased shear strength with increasing depth below top of ground. In addition, a site-specific correlation between shear strength versus plasticity index is

TABLE 6

SUMMARY OF LABORATORY TORQUE VANE TESTS

Boring No.	Sample No. and Depth	Corresponding Plasticity Index	Shear Strength	
			Peak	Residual
BW-101	U-3 (6-8 ft.)	71.2	123	20
BW-101	U-4 (12-14 ft.)	17.7	41	10
BW-106	U-1 (6-8 ft.)	54.7	338	45
			338	40

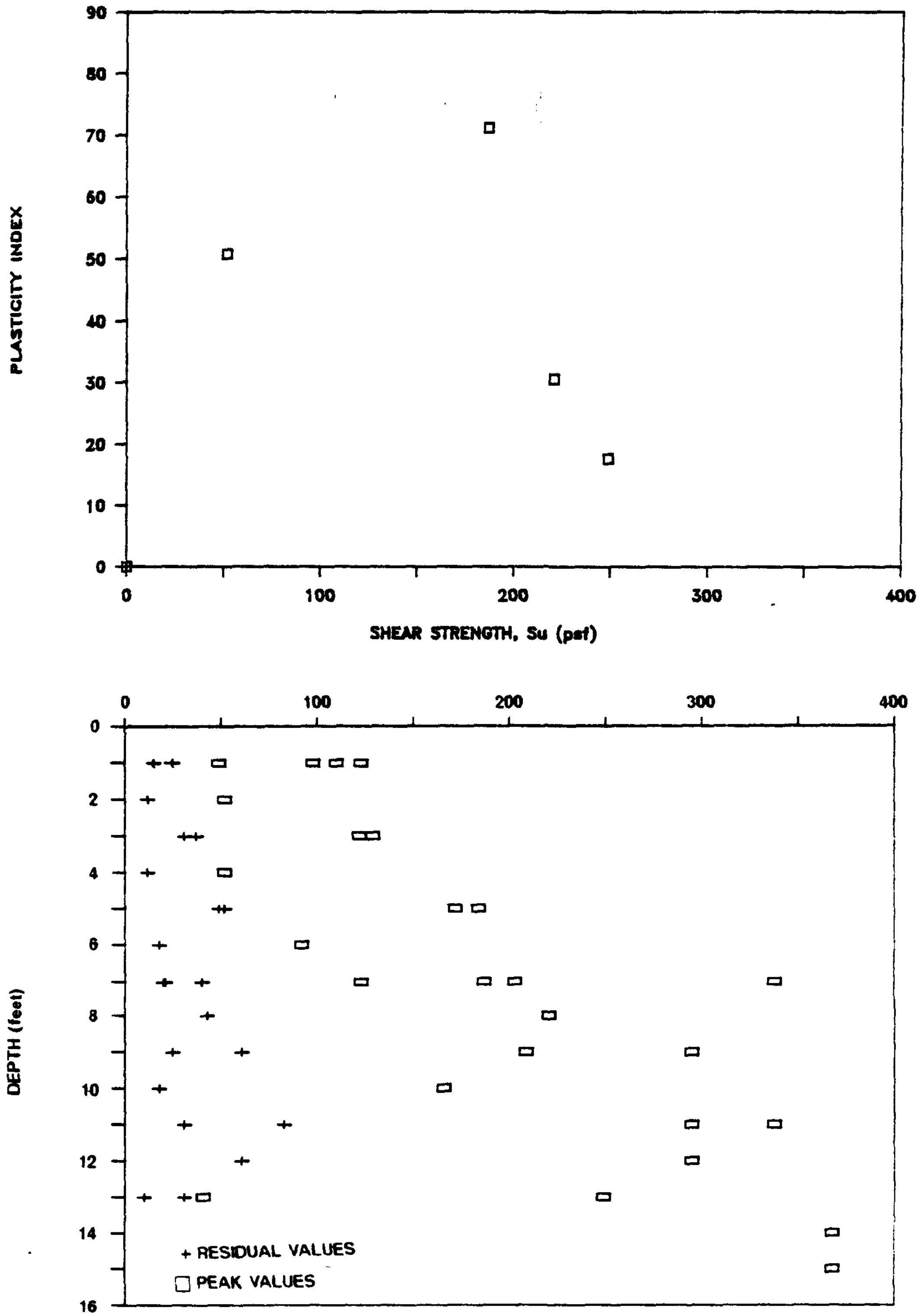

FIGURE 5
ORGANIC SILT CHARACTERISTICS - SHEAR STRENGTH INDEXING
PRELIMINARY GEOTECHNICAL INVESTIGATION
OF ENGINEERING PROPERTIES
NEW BEDFORD HARBOR SUPERFUND SITE
BRISTOL COUNTY, MASSACHUSETTS
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presented on the top portion of Figure 5. As expected, when plasticity increases the strength generally decreases.

4.0 SUBSURFACE CONDITIONS

The preliminary geotechnical exploration program has shown that subsurface conditions throughout the project area (Figure 1) are highly variable in terms of color, texture, composition (clay, silt, sand, gravel, cobbles, boulders, etc.), densification, moisture content, etc. Type and depth to bedrock are also highly variable. In general, the subsurface conditions consist predominately of cross-bedded granular soils, although some portions of the project area have significant organic silt deposits as well.

Subsurface condition information is of vital importance when selecting and analyzing various remediation alternatives. The exploration program focused on seven specific areas within the project area for disposal and containment purposes. The extent of the areas is outlined in Figure 2. For discussion purposes, the seven areas can be categorized as follows:

- Marsh Island area
- North Terminal area
- Conrail Rail Yard area
- Area between Marsh and Popes Islands
- Area between the South Terminal area and Palmer Island
- Area slightly south of the hurricane barrier, as designated by boring BW-107

- Area south of the hurricane barrier, as designated by borings BW-108A and BW-108B

Subsequent subsections briefly summarize the subsurface conditions encountered at each of the previously listed areas. Engineering logs are provided in Appendix A.

4.1 MARSH ISLAND AREA

Geotechnical explorations on Marsh Island have indicated that bedrock dips from boring BL-108 to BL-107 (north/northeasterly direction) with recorded bedrock elevations at -38.3 and -47.3 feet, respectively. Refusal for probe PL-101 was in between, as expected, at elevation -43.8 feet.

Subsurface soils consisted of medium dense sand, with the exception of dense to very dense conditions near bedrock. Color varied from brown, gray, olive, and tan. The texture ranged from fine sand to a fine to coarse sand with a predominance of fine to medium textured sand. Sediment thickness to bedrock was 58.6, 44.6, and 52.9 feet for explorations BL-107, BL-108, and PL-101, respectively.

4.2 NORTH TERMINAL AREA

Preliminary geotechnical explorations have shown that the most extensive organic silt deposit in the project area is in the North Terminal Area. Thickness of the organic silt decreased from approximately 15 feet at borings BW-101 and 2 (GZA, 1985) and "pinched" to nothing at borings BL-105 and BL-106. The organic silt in this deposit was extensively tested in Jordan's geotechnical laboratory. Results and a more complete discussion of its classification and engineering properties are presented in Section 3.0.

Bedrock in the North Terminal Area was basically a gray to pink fine grained gneissic granite. Bedrock depths or refusal depths (assumed to represent bedrock) within the area varied greatly. Depths range from 25.5 to at least 47.8 feet. Only borings BW-101, BL-105, and BL-106 are referenced to MSL elevation; therefore, depth comparisons are not possible.

Beneath the organic silt deposit lies cross bedded granular soils with two exceptions: (1) a brown clayey silt stratum was discovered in borings 4 and 5, with a thickness of 4.5 and 12 feet at a depth of 7.5 and 5 feet for borings 4 and 5, respectively; and (2) fill material (ash, brick, gravel, sand, etc.) comprise the uppermost 9 to 12 feet for borings BL-105 and BL-106.

The cross-bedded granular soils are made up of a predominance of medium dense sand with occasional layers of loose, dense or very dense sand. The texture of the sand ranged from fine to fine-to-coarse. The sand was generally gray in color but brown and grayish-brown existed as well.

4.3 CONRAIL RAIL YARD AREA

The Conrail Rail Yard area consists of various-colored (gray, brown, brown and black, olive, etc.) sandy cross-bedded granular soils except for approximately 9 feet of fill material (ash, brick, gravel, sand, etc.) at boring BL-101. The texture of the sand ranged from fine to fine-to-coarse with the greatest portion being fine-to-coarse.

Bedrock (gray to pink gneissic granite) depths were varied. Their depths and reference to MSL elevations for borings BL-101, BL-102, BL-103, and BL-104 are 23.3 and -15.4 feet, 6.3 and 1.1 feet, 52.3 and -45.2 feet, and 35.7 and -30.0 feet, respectively.

4.4 AREA BETWEEN MARSH AND POPES ISLANDS

The subsurface conditions are highly variable in the area between Marsh and Popes Islands. They range from cross-bedded granular soils to organic silt to peat.

The cross-bedded granular soils consist mostly of sand. Density of the granular soils ranges from very loose to very dense. In general (aside from boring BW-110), the relative density of the cross-bedded granular soils tends to be high at or near the top of the stratum and then decreases with depth until a loose condition is reached. Upon approaching the bedrock the density suddenly increases to its greatest value.

In comparison, boring BW-110 does not exhibit this behavior. Additionally, BW-110 is the only exploration in this area that has a stratum of peat. The peat is 8.5 feet thick, beginning at a depth of 23.0 feet.

Organic silt was found only at the surface in borings BW-109A, BW-110, and BW-112 at thicknesses of 4, 10, and 2.5 feet, respectively. Beneath the organic silt was a silty sand stratum with a thickness ranging from 3.5 to 8 feet.

The organic silt in this area is very soft and ranges in plasticity from high to very high. The organic silt was tested in

Jordan's geotechnical laboratory (see Section 3.0 for a more detailed outline of its classification and engineering properties).

Bedrock and assumed bedrock depths were greatest in this area in comparison to the other containment and disposal areas. Bedrock depths and MSL elevations for borings BW-109A, BW-110, BW-111, and BW-112 are 42.8 and -51.7 feet, 62.0 and -70.3 feet, 73.0 and -78.7 feet, and 42.8 and -49.1 feet, respectively. The bedrock dip appears to be in the northeasterly direction.

4.5 AREA BETWEEN THE SOUTH TERMINAL AREA AND PALMER ISLAND

The area between the South Terminal area and Palmer Island is composed mostly of cross-bedded granular soils. Exceptions to this are as follows:

- o Organic silt stratum 8.7 feet thick from a depth of 10 to 18.7 feet at boring BW-103. Some characteristics of this stratum are:
  - very soft
  - high plasticity (observation)

  - similar to organic silt tested in Jordan's laboratory (see Section 3.0)

- Two-and-one-half-foot thick stratum of silty fine sand at the surface of boring BW-105. Some characteristics of this stratum are:

  - very soft to soft

  - low plasticity (observation)

  - organic (H_2S) odor not prevalent

  - doesn't appear to be the same as other organic silty soil tested in the laboratory

- Two-foot thick sandy silt stratum. Some characteristics of this stratum are:

  - very soft to soft

  - very high plasticity

  - strong organic (H_2S) odor

- appears to be similar to organic silty soil tested in Jordan's laboratory

The cross-bedded granular soils comprise mostly medium dense sand, although low to dense sand is present as well. The texture of the sandy soils ranges from fine to fine-to-coarse with a major portion being fine-to-coarse. The color of the sandy soils varies from gray (various shades), brown, grayish-brown, and tan with no apparent scheme.

Bedrock (pink fine grained gneissic granite) or assumed bedrock depths range from 14.5 to 32.8 feet (MSL elevations of -20.5 to -38.8 feet). No obvious dip to the bedrock appears to be apparent.

4.6 AREA SLIGHTLY SOUTH OF THE HURRICANE BARRIER (BW-107)

Bedrock (pink medium grained granite) was encountered at a depth of 28.7 feet and an MSL elevation of -45.9 feet. Preliminary information indicates that the bedrock dips in the north/northeast direction.

A 2-foot thick stratum of very soft, highly plastic, organic silt is the uppermost sediment in this area. The organic silt encountered in this area is very similar to other organic silts in the project area that have been tested in Jordan's geotechnical laboratory (see Section 3.0 for more comprehensive information concerning its classification and engineering properties).

Beneath the organic silt lies a variety of soil types with predominance of a medium dense non-plastic tan sandy silt from a depth of 8.5 to 23.7 feet. The remaining depth of 28.7 feet (MSL elevation of -45.9 feet) consists of various sandy soils. Colors and textures of soils vary somewhat but are generally made up of medium dense brown fine to medium or coarse sand.

4.7 AREA SOUTH OF HURRICANE BARRIER (BW-108A and BW-108B)

Three-and-one-half feet of dark gray organic silt overlays 4.5 feet of granular soil below which is assumed bedrock (based on refusal of split-spoon sampler). Elevation at the assumed bedrock surface is -19.4 feet. Preliminary information indicates the dip of the bedrock is in the north/northeast direction.

The organic silt in this area is very soft and highly plastic. Similar organic silt from the project area was tested in Jordan's geotechnical laboratory (refer to Section 3.0 for discussions regarding its classification and engineering properties).

The granular soils consist of a very dense 3-foot stratum of brownish gray gravelly fine sand (glacial till) overlain by 1.5 feet of loose brown fine sand.

5.0 LIST OF SYMBOLS AND ACRONYMS

ASTM	American Society of Testing and Materials
c	cohesion
C	2-inch thin-walled tube
EBASCO	Ebasco Services, Inc.
EPA	Environmental Protection Agency
e_o	void ratio
FS	Feasibility Study
FVST	field vane shear test
G_s	specific gravity
ID	inside diameter
JORDAN	E.C. Jordan
MSL	Mean Sea Level
O_c	organic content
OD	outside diameter
OSHA	Occupational Safety and Health Administration
PCB	polychlorinated biphenyl
pcf	pounds per cubic foot
ppm	parts per million
psf	pounds per square foot
R	rock
RI/FS	Remedial Investigation/Feasibility Study
S	split spoon
SPT	Standard Penetration Test
U	3-inch thin-walled tube
USACE	U.S. Army Corps of Engineers

5.0 LIST OF SYMBOLS AND ACRONYMS

W_c	water content
WOC	weight of casing
WOM	weight of man
γ_{wet}	wet density
ϕ	internal friction angle

APPENDIX A

ENGINEERING LOGS

APPENDIX A

TABLE OF CONTENTS

KEY TO SOIL DESCRIPTIONS

UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS			GROUP SYMBOLS	TYPICAL NAMES
COARSE-GRAINED SOILS (More than half of material is larger than No. 200 selve size)	GRAVELS (More than half of coarse fraction is larger than No. 4 sieve size)	CLEAN GRAVELS (Little or no fines)	GW	Well-graded gravels, gravel-sand mixtures, little or no fines.
			GP	Poorly-graded gravels, gravel-sand mixtures, little or no fines
		GRAVELS WITH FINES (Appreciable amount of fines)	GM	Silty gravels, gravel-sand-silt mixtures
			GC	Clayey gravels, gravel-sand-clay mixtures
	SANDS (More than half of coarse fraction is smaller than No. 4 sieve size)	CLEAN SANDS (Little or no fines)	SW	Well-graded sands, gravelly sands, little or no fines
			SP	Poorly-graded sands, gravelly sand, little or no fines
		SANDS WITH FINES (Appreciable amount of fines)	SM	Silty sands, sand-silt mixture
			SC	Clayey sands, sand-clay mixtures
FINE-GRAINED SOILS (More than half of material is smaller than No. 200 sieve size)	SILTS AND CLAYS (Liquid limit less than 50)		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
			OL	Organic silts and organic silty clays of low plasticity
	SILTS AND CLAYS (Liquid limits greater than 50)		MW	Inorganic silts, micaceous or diatomaceousfine sandy or silty soils, elastic silts
			CH	Inorganic clays of high plasticity, fat clays
			OH	Organic clays of medium to high plasticity, organic silts
	HIGHLY ORGANIC SOILS		Pt	Peat and other highly organic soils

TERMS DESCRIBING CONDITION, CONSISTENCY AND HARDNESS

COARSE GRAINED SOILS (major portion retained on No. 200 sieve); Includes (1) clean gravels; (2) silty or clayey gravels; and (3) silty, clayey or gravelly sands. Consistency is rated according to standard penetration resistance.

DESCRIPTIVE TERM	STANDARD PENETRATION RESISTANCE IN BLOWS/FT.
Very loose	0 to 4
Loose	5 to 10
Medium dense	11 to 30
Dense	31 to 50
Very dense	Over 50

FINE GRAINED SOILS (major portion passing No. 200 sieve): Includes (1) inorganic and organic silts and clays; (2) gravelly, sandy or silty clays: and (3) clayey silts. Consistency is rated according to shearing strength, as indicated by penetrometer readings, vane test, or by triaxial test.

DESCRIPTIVE TERM	SHEAR STRENGTH (ksf)
Very soft	less than 0.25
Soft	0.25 to 0.50
Firm	0.50 to 1.00
Stiff	1.00 to 2.00
Very stiff	2.00 to 4.00
Hard	4.00 and higher

SIZE PROPORTIONS

DESIGNATION	PERCENT BY WEIGHT
Trace	0 to 10
Little	10 to 20
Some	20 to 35
Silty, Sandy or Gravelly	35 to 50

KEY TO SOIL SAMPLE AND TESTING DATA

SAMPLE TYPE

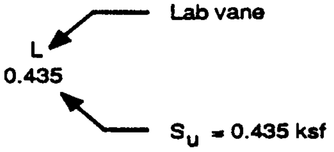
☒ 2" Split Spoon Sampler
■ Thin Wall Tube
☐ No Recovery
▥ Rock

THIN WALL TUBE SAMPLING METHOD

PUSH = Hydraulically pushed
H = Pushed with static weight of drill rods
P = Piston sampler

SHEAR STRENGTH

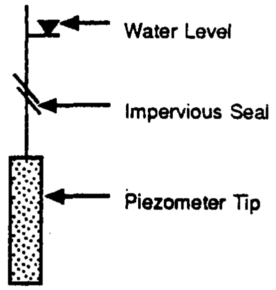
F = Field vane
L = Lab vane
T = Torvane
P = Pocket penetrometer



LABORATORY TEST

G = Grain size anlaysis
H = Hydrometer analysis
A = Atterberg limit
T = Triaxial compression test
U = Unconfined compression test
D = Direct shear test
S = Specific Gravity
O = Organic Content
St = Staged Triaxial Test

PIEZOMETER DATA



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KEY TO SOIL DESCRIPTIONS AND EXPLORATION LOG

DEPTH (FT.)	CASING BLOWS/FT.	SAMPLE NO. PENETRATION/RECOVERY	LAB TEST	WATER CONTENT (%)	SHEAR STRENGTH, Su PEAK/RESIDUAL (psf) ROD PROBE (BLOWS/FT.)	SOIL DESCRIPTION		SOIL CLASS	STANDARD PENETRATION RESISTANCE BLOWS/FT 0 10 20 30 40 50 60	PIEZOMETER DATA	ELEV. (FT.)
0						ORGANIC SILT	Dark gray organic silt, trace fine sand, H_2S odor.				
1	WOC WOC										
2		U-1 H 2.0 0.9	G	52.1 91.5 91.8	98.2/25 129/31		Some shell fragments and living shell organisms, very soft, wet.				
3											
4											
5		U-2 H 2.0 poor			172/49						
6		U-3 H 1.0 1.2	G H S O	91.5 91.8 86.4	187/40						
7											
8		S-1 2.0 1.1		83.0	295/61		Trace shell fragments (no live shell organisms).				
9									WOR		
10		S-2 2.0 0.8		73.1	338/83						
11									WOR		
12		U-4 H 2.0 2.0	G H A S O ST	75.1 54.0 36.7	249/31						
13											
14		S-3 2.0 2.0		55.4		15.0	Layer, 1.0', dark gray fine sandy silt, very soft, H_2S odor.				
15					368+/92	SILTY SAND	Dark gray silty fine sand, very loose, H_2S odor, moist.		WOM		
16		S-4 2.0 1.1		42.0							
17	WOC								WOM		
18	14	S-5 2.0 1.2		31.9		18.5	Gray, loose.		27		
19	26					SAND	Gray fine to coarse sand, little gravel, trace silt, medium dense downward gradient observed (drill fluid flowing into stratum), moist.				
20	10										
21	11										
22	9										
23	3	S-6 2.0 0.95	G	17.7			Fine sand, trace coarse sand, trace medium sand, loose.		9		
24	23										
25	34										
26	37										
27	36										
28	18	S-7 2.0 1.4					Trace gravel, medium dense, uniformily graded.		14		
29	21										
30	18										
31	23										
32	59										
33	32	S-8 2.0 1.2					0.85'-1.2' Grayish brown fine sand, trace medium sand, dense, well graded, moist. 0.0'-0.85' Fine to coarse sand, little gravel, dense gap graded, moist.		37		
34	26										
35	34										
36	54						Trace gravel, very dense.				
37	49					49.5 WEATHERED ROCK	Grayish brown weathered rock (quartz and mica fragments), little silt, trace sand, very dense, moist.				
38	76	S-9 1.0 0.7							100+		
39		*R-1									
40											

U: 3" or 3½" thin wall tube S: split spoon R: rock C: 2" thin wall tube

PRELIMINARY GEOTECHNICAL INVESTIGATION
OF ENGINEERING PROPERTIES
NEW BEDFORD HARBOR SUPERFUND SITE
BRISTOL COUNTY, MASSACHUSETTS

E.C.JORDAN CO.
CONSULTING ENGINEERS

Engineering Log of: BW-101		Page 1/2
Project No. 4959-19	Date Drilled 1/22 - 1/26/88	Sheet A-3

DEPTH (FT.)	CASING BLOWS/FT.	SAMPLE NO. PENETRATION/RECOVERY	SAMPLE	LAB TEST	WATER CONTENT (%)	SHEAR STRENGTH, Su PEAK/RESIDUAL (psf) ROD PROBE (BLOWS/FT.)	SOIL DESCRIPTION	SOIL CLASS	STANDARD PENETRATION RESISTANCE BLOWS/FT 0 10 20 30 40 50 60	PIEZOMETER DATA	ELEV. (FT.)
40		*R-1 4.0 2.75					Gray to pink fine grained gneissic granite (fine grained pegmatite), occasional xenolith of pink fine grained granite, some large quartz inclusions, trace sulfide inclusions. RQD = 59.0%				
41							41.75				
42											
43											
44											
45							BOTTOM OF EXPLORATION AT 41.75 FEET				
50							* Rock core obtained with a double barrel N core and NWX core bit.				
55											
60											
65											
70											
75											
80											

U: 3" or 3½" thin wall tube   S: split spoon   R: rock   C: 2" thin wall tube

PRELIMINARY GEOTECHNICAL INVESTIGATION
OF ENGINEERING PROPERTIES
NEW BEDFORD HARBOR SUPERFUND SITE
BRISTOL COUNTY, MASSACHUSETTS

E.C.JORDAN CO.
CONSULTING ENGINEERS

Engineering Log of: BW-101		Page 2/2
Project No. 4959-19	Date Drilled 1/22 - 1/26/88	Sheet A-4

DEPTH (FT.)	CASING BLOWS/FT.	SAMPLE NO. PENETRATION/RECOVERY	SAMPLE	LAB TEST	WATER CONTENT (%)	SHEAR STRENGTH, Su PEAK/RESIDUAL (psf) ROD PROBE (BLOWS/FT.)	SOIL DESCRIPTION		SOIL CLASS	STANDARD PENETRATION RESISTANCE BLOWS/FT 0 10 20 30 40 50 60	PIEZOMETER DATA	ELEV. (FT.)
0–2	5 2						SAND	Dark gray fine to medium sand, some shell fragments, little gravel, trace coarse sand, trace silt, very loose, wet.				
2–4	3 3	S-1 2.0 0.75								3		
4–6	3 3	S-2 2.0 1.0						0.4'-1.0' Fine to coarse sand. 0.0'-0.4' Fine to medium sand, little silt, very loose		2		
6–8	1 3	S-3 2.0 poor			12.6			Medium gray medium to coarse sand, some shell fragments, trace fine sand, very loose, wet.		1		
8–10	7 6	S-4 2.0 0.6			18.6		10.0	Dark gray fine sand, little gravel, trace coarse sand, trace medium sand, trace shell fragments, loose, wet.		10		
10–12	4 7	S-5 2.0 1.4			47.8		ORGANIC SILT	1.0'-1.4' Dark gray organic silt, some fine to coarse sand, little gravel, very soft, H_2S odor, wet.		WOR		
12–14	7 6	S-6 2.0 1.8		G H O	59.2 60.3			0.0'-1.0' Little fine sand, trace organics, no gravel, wet.		WOR		
14–16	5 6	S-7 2.0 2.0			55.1			Layer 1.1' thick, dark gray gravelly silt.		2		
16–18	12 12	S-8 2.0 1.6			59.8			Some gravel, some sand, H_2S odor, layer 0.6' dark gray silty fine sand, layer 0.3' dark brown peat, layer 0.2' light gray fine to medium sand.		2		
18–20	24 25	S-9 2.0 1.7			60.0		18.7 GRAVEL	Dark gray organic silt, very soft, H_2S odor, moist. layer 0.2' dark brown peat		35		
20–23	22 28 27						23.0	Light gray fine to coarse gravel, trace silt, moist.				
23–25.5		S-10 2.0 1.3		G	10.5		SAND 25.5	Brown fine to coarse sand (multi colored grains - black, rust, white, etc.), loose, well graded, moist.		6		

☆ REFUSAL SURFACE ENCOUNTERED AT DEPTH OF 25.5 FEET

☆ Refusal of drilling tools and sampling equipment with methods used. Refusal surface is assumed to represent bedrock.

U: 3" or 3½" thin wall tube S: split spoon R: rock C: 2" thin wall tube

PRELIMINARY GEOTECHNICAL INVESTIGATION
OF ENGINEERING PROPERTIES
NEW BEDFORD HARBOR SUPERFUND SITE
BRISTOL COUNTY, MASSACHUSETTS

E.C.JORDAN CO.
CONSULTING ENGINEERS

Engineering Log of: BW-103

Project No.	Date Drilled	
4959-19	1/15/88	Sheet A-5

DEPTH (FT.)	CASING BLOWS/FT.	SAMPLE NO. PENETRATION/RECOVERY	SAMPLE	LAB TEST	WATER CONTENT (%)	SHEAR STRENGTH, Su PEAK/RESIDUAL (psf) ROD PROBE (BLOWS/FT.)		SOIL DESCRIPTION	SOIL CLASS	STANDARD PENETRATION RESISTANCE BLOWS/FT	PIEZOMETER DATA	ELEV. (FT.)
0	9						SAND	Dark gray fine sand, some shell fragments.				
1	5											
2	2	S-1 2.0/0.8						Little silt, very loose, well graded, wet.		3		
3	3											
4	4	S-2 2.0/0.7						Medium gray fine sand, some shell fragments, trace gravel, trace silt, loose, well graded, wet.		8		
5	4											
	3	S-3 2.0/poor						Coarse sand wash material.		5		
	7											
	5	S-4 2.0/0.9			18.9			Brown fine sand, loose, uniformly graded, wet. Layer of sandy gravel, some shell fragments. Medium dense.		10		
	8											
10	5	S-5 2.0/poor		G	19.1			Layer of sandy gravel, some shell fragments.		17		
	7											
	12	S-6 2.0/1.3			23.4			Trace gravel, medium dense, uniformly to well graded.		16		
	12											
	27	S-7 2.0/1.4		G	18.1			Brown fine to coarse sand, some shell fragments, trace gravel, wet. Layer, 0.8', sandy silt. No shell fragments, no gravel.		22		
15	20											
	18											
	19											
	15											
	15											
20	16	S-8 2.0/1.6			19.1			Layer, 0.3', fine sand. Layer, 0.8', fine to medium sand. *Grayish brown fine to coarse sand,* some gravel, well graded, wet.		6		
	17											
	22											
	25											
	25											
25	43	S-9 2.0/1.3		G	11.1			Light gray fine to coarse sand, well graded, dense, wet.		20		
	48							Black and rust silty fine sand, wet.				
	55							Wash contains medium to coarse sand.				
	58											
	51											
30		S-10 2.0/1.0			9.3			Tan (multi colored grains) fine to coarse sand, trace gravel, medium dense, wet. Nose of spoon contained weathered rock (i.e., sandy silt, predominance of mica fragments), piece of black granite in tip of spoon.		21		
							32.8					
35												
40												

* REFUSAL SURFACE ENCOUNTERED AT DEPTH OF 32.8 FEET

* Refusal of drilling tools and sampling equipment with methods used. Refusal surface is assumed to represent bedrock.

U: 3" or 3½" thin wall tube S: split spoon R: rock C: 2" thin wall tube

PRELIMINARY GEOTECHNICAL INVESTIGATION OF ENGINEERING PROPERTIES NEW BEDFORD HARBOR SUPERFUND SITE BRISTOL COUNTY, MASSACHUSETTS

E.C.JORDAN CO.
CONSULTING ENGINEERS

Engineering Log of: BW-104

Project No. 4959-19

Date Drilled 1/13 - 1/14/88

Sheet A-6

DEPTH (FT.)	CASING BLOWS/FT.	SAMPLE NO. PENETRATION/RECOVERY	SAMPLE	LAB TEST	WATER CONTENT (%)	SHEAR STRENGTH, Su PEAK/RESIDUAL (psf) ROD PROBE (BLOWS/FT.)	SOIL DESCRIPTION	SOIL CLASS	STANDARD PENETRATION RESISTANCE BLOWS/FT 0 10 20 30 40 50 60	PIEZOMETER DATA	ELEV. (FT.)
0	1						SAND Medium gray silty fine sand, some shell fragments, H_2S odor.				
1	4										
2	7	S-1	☒				Brown fine sand, trace gravel, some shell fragments, medium dense, well graded, wet.				
3	1	2.0/1.0	☒						15		
4	3	S-2	☒	G	12.1		Layer, 0.7', fine sand.				
5	3	2.0/poor	☒				Trace shell fragments.		13		
	11										
	15										
	18										
	16										
10	20	S-3 2.0	☒				Brown fine to coarse sand, trace gravel, loose, wet.		8		
	19	0.75	☒								
	27										
	35						14.5				
15											
20											
25											
30											
35											
40											

* REFUSAL SURFACE ENCOUNTERED AT DEPTH OF 14.5 FEET

* Refusal of drilling tools and sampling equipment with methods used. Refusal surface is assumed to represent bedrock.

U: 3" or 3½" thin wall tube S: split spoon R: rock C: 2" thin wall tube

PRELIMINARY GEOTECHNICAL INVESTIGATION
OF ENGINEERING PROPERTIES
NEW BEDFORD HARBOR SUPERFUND SITE
BRISTOL COUNTY, MASSACHUSETTS

E.C.JORDAN CO.
CONSULTING ENGINEERS

Engineering Log of: BW-105

Project No.	Date Drilled	
4959-19	1/8/88	Sheet A-7

DEPTH (FT.)	CASING BLOWS/FT.	SAMPLE NO. PENETRATION/RECOVERY	LAB TEST	WATER CONTENT (%)	SHEAR STRENGTH, Su PEAK/RESIDUAL (psf) ROD PROBE (BLOWS/FT.)	STRATUM	SOIL DESCRIPTION	SOIL CLASS	STANDARD PENETRATION RESISTANCE BLOWS/FT 0 10 20 30 40 50 60	PIEZOMETER DATA	ELEV. (FT.)
0	3					SAND	Medium gray fine sand, little shell fragments.				
1	3										
2	1	S-1 2.0 poor					Trace gravel, trace coarse sand, trace shell fragments, very loose, uniformly graded, wet.		4		
3	9										
4	6	S-2 2.0 1.3					No gravel. Layer, 0.45', dark gray, silty fine sand, very soft, H_2S odor.		1		
5	1					6.0					
6	WOC	U-1 H 2.0 1.9	G H A S O	63.6 65.8 82.2 98.8		SANDY SILT	Dark gray fine sandy silt, very soft, H_2S odor, wet.		WOM (2)		
7	WOC					8.0					
8	18	S-3 2.0 1.6		30.9			Light to medium gray fine sand, little silt, trace gravel, trace shell fragments, very loose, well graded, wet.		2		
9	18										
10	35	S-4 2.0 1.3		15.7			Little to some shell fragments, loose.		33		
11	29					12.0	Light gray fine sand, trace silt, medium dense, wet.				
12	46	S-5 2.0 0.6		15.5		GRAVELLY SAND	Light to medium gray gravelly fine to coarse sand, gap graded, medium dense, wet.		21		
13	40										
14	36	S-6 2.0 0.9	G	11.4 13.5			Medium gray, trace silt, well graded, wet.		21		
15	50										
16	41										
17	48										
18	68					19.0					
19	61	S-7 2.0 0.5	G	8.3		SAND	Brown fine to medium sand, some gravel, trace silt, gap graded, very dense, wet.		60		
20	65					21.7					
21.7		*R-1 5.0					BEDROCK AT 21.7 FEET Pink fine grained gneissic granite, massive, some well healed fractures, trace chloritization. RQD = 59.0%				
25						26.7					
26.7							BOTTOM OF EXPLORATION AT DEPTH OF 26.7 FEET				
30											
35											
40											

* Rock core obtained with a double barrel N core and NWX core bit.

U: 3" or 3½" thin wall tube S: split spoon R: rock C: 2" thin wall tube

PRELIMINARY GEOTECHNICAL INVESTIGATION OF ENGINEERING PROPERTIES NEW BEDFORD HARBOR SUPERFUND SITE BRISTOL COUNTY, MASSACHUSETTS

E.C.JORDAN CO.
CONSULTING ENGINEERS

Engineering Log of:	BW-106

Project No.	Date Drilled	
4959-19	1/19/88	Sheet A-8

DEPTH (FT.)	CASING BLOWS/FT.	SAMPLE NO. PENETRATION/RECOVERY	SAMPLE	LAB TEST	WATER CONTENT (%)	SHEAR STRENGTH, Su PEAK/RESIDUAL (psf) ROD PROBE (BLOWS/FT.)	SOIL CLASS	SOIL DESCRIPTION	STANDARD PENETRATION RESISTANCE BLOWS/FT	PIEZOMETER DATA	ELEV. (FT)
0–1	WOC						ORGANIC SILT	Dark gray organic silt, some fine sand, H_2S odor.			
1–2	5						2.0				
2–3	2	S-1 2.0/poor	☒				SAND	Dark gray medium to coarse sand, little gravel, little shell fragments, trace fine sand, very loose, H_2S odor, wet.	2		
3–4	2		☒								
4–5	6	S-2 2.0/1.0	☒					0.5'-1.0' Brownish gray fine to medium sand, trace coarse sand, trace shell fragments. 0.0'-0.5' medium to coarse sand, trace fine sand.	8		
5–6	18		☒				6.0				
6–7	10	S-3 2.0/0.6	☒				SANDY GRAVEL	Brownish gray fine to coarse sandy gravel, wet. Gray fine sandy gravel, little silt, trace medium to coarse sand, wet.	10		
7–8	5		☒				8.5	Grayish brown fine sandy gravel, wet.			
8–9	7	S-4 2.0/2.0	☒				SANDY SILT	Tannish brown fine sandy silt, medium dense, well graded, wet.	21		
9–10	5		☒								
10–11	5	S-5 2.0/1.3	☒						19		
11–12	6		☒								
12–13	8	S-6 2.0/1.0	☒	G D	43.0				12		
13–14	10		☒								
14–15	10	S.7 2.0/1.1	☒						17		
15–16	11		☒								
16–17	15										
17–18	12	S-8 2.0/1.0	☒						20		
18–19	12		☒								
19–20	19										
20–21	19										
21–22	20										
22–23	59	S-9 2.0/1.0	☒					some silt to silty, little gravel, trace medium sand, trace coarse sand, dense.	34		
23–24	52		☒				23.7 SAND	Brown fine to medium sand, some gravel, trace coarse sand, dense, wet.			
24–25	42										
25–26	45										
26–27	47							Fine to coarse sand, some silt, little gravel.			
27–28	36	S-10 1.7/0.9	☒					Fine sand, trace gravel, trace silt.	100+		
28–28.7	99		☒				28.7	Organish brown fine to coarse sand, some rock fragments, trace gravel, wet			
28.7–31.95		*R-1 3.5/3.25					31.95	BEDROCK AT 28.7' Pink medium grained granite, massive. RQD = 87.7%			

BOTTOM OF EXPLORATION AT
DEPTH OF 31.95 FEET

* Rock core obtained with a double barrel N core and NWX core bit.

U: 3" or 3½" thin wall tube S: split spoon R: rock C: 2" thin wall tube

PRELIMINARY GEOTECHNICAL INVESTIGATION
OF ENGINEERING PROPERTIES
NEW BEDFORD HARBOR SUPERFUND SITE
BRISTOL COUNTY, MASSACHUSETTS

E.C.JORDAN CO.
CONSULTING ENGINEERS

Engineering Log of: BW-107

Project No. 4959-19

Date Drilled 2/11/88

Sheet A-9

DEPTH (FT.)	CASING BLOWS/FT.	SAMPLE NO. PENETRATION/RECOVERY	SAMPLE	LAB TEST	WATER CONTENT (%)	SHEAR STRENGTH, Su PEAK/RESIDUAL (psf) ROD PROBE (BLOWS/FT.)	SOIL DESCRIPTION		SOIL CLASS	STANDARD PENETRATION RESISTANCE BLOWS/FT 0 10 20 30 40 50 60	PIEZOMETER DATA	ELEV. (FT.)
0							SANDY ORGANIC SILT	Dark gray sandy organic silt, very soft, H_2S odor.				
1	WOC							*Layer, 0.5', medium gray gravelly fine sand, trace silt, trace fragments, wet.*				
2	2	S-1 0.9/2.0	☒	G	7.3	123/25						
3	13						3.0			5		
							SAND	Brown fine sand, trace silt, gray mottling, wet.				
4	10	S-2 1.0/0.0	☒									
5							5.0	No recovery		100+		

* REFUSAL SURFACE ENCOUNTERED
AT DEPTH OF 5.0 FEET

* Refusal of drilling tools and sampling equipment with methods used. Refusal surface is assumed to represent a large boulder.

10 15 20 25 30 35 40

U: 3" or 3½" thin wall tube S: split spoon R: rock C: 2" thin wall tube

PRELIMINARY GEOTECHNICAL INVESTIGATION
OF ENGINEERING PROPERTIES
NEW BEDFORD HARBOR SUPERFUND SITE
BRISTOL COUNTY, MASSACHUSETTS

E.C.JORDAN CO.
CONSULTING ENGINEERS

Engineering Log of: BW-108A		
Project No. 4959-19	Date Drilled 1/21/88	Sheet A-10

Depth (Ft.)	Casing Blows/Ft.	Sample No. Penetration/Recovery	Sample	Lab Test	Water Content (%)	Shear Strength, Su Peak/Residual (psf) Rod Probe (Blows/Ft.)	Soil Description		Soil Class	Standard Penetration Resistance Blows/Ft 0 10 20 30 40 50 60	Piezometer Data	Elev. (Ft.)
0	WOC						SANDY ORGANIC SILT	Dark gray sand organic silt, very soft, H_2S odor.				
1	3											
2	13							Layer, 0.5', medium gray gravelly fine sand, trace silt, trace shell fragments.				
3	16						3.5					
4	X			G	10.2		SAND 5.0	Brown fine sand, trace silt, some gravel, trace medium sand, very dense, wet.				
5	X	S-1					GRAVELLY SAND (Glacial Till)	Brownish gray gravelly fine sand, little silt, trace coarse sand, very dense, wet.			163	
6		S-2						Layer, 0.7', brown to coarse sand.			87	
7							8.0	Gray silty fine sand, some gravel, trace med. to coarse sand, v.dense, wet.				

*REFUSAL SURFACE ENCOUNTERED AT DEPTH OF 8.0 FEET

* Refusal of drilling tools and sampling equipment with methods used. Refusal surface is assumed to represent bedrock.

10

15

20

25

30

35

40

U: 3" or 3½" thin wall tube S: split spoon R: rock C: 2" thin wall tube

PRELIMINARY GEOTECHNICAL INVESTIGATION
OF ENGINEERING PROPERTIES
NEW BEDFORD HARBOR SUPERFUND SITE
BRISTOL COUNTY, MASSACHUSETTS

E.C.JORDAN CO.
CONSULTING ENGINEERS

Engineering Log of: BW-108B

Project No.	Date Drilled	
4959-19	1/21/88	Sheet A-11

DEPTH (FT.)	CASING BLOWS/FT.	SAMPLE NO. PENETRATION/RECOVERY	SAMPLE	LAB TEST	WATER CONTENT (%)	SHEAR STRENGTH, Su PEAK/RESIDUAL (psf) ROD PROBE (BLOWS/FT.)	SOIL DESCRIPTION		SOIL CLASS	STANDARD PENETRATION RESISTANCE BLOWS/FT 0 10 20 30 40 50 60	PIEZOMETER DATA	ELEV. (FT.)
0							SANDY ORGANIC SILT	Dark gray sandy organic silt, little shell fragments, H_2S odor. Very soft, wet.				
1	WOC											
2	WOC					49/15						
3		S-1 2.0 poor								WOR		
4						122/37	4.0					
5		S-2 2.0 poor		G	114.9		SILTY SAND	Dark gray silty sand, little shell fragments, very loose, H_2S odor, wet.		WOR		
						184/52						
		S-3 2.0						No recovery.		WOR		
						203/21						
		S-4 2.0 0.5				209/25				WOR		
10	WOC							Medium dark gray silty sand, little gravel, little shell fragments, medium dense, wet.				
	7	S-5 2.0 0.8				295/31				19		
	26						12.0	Layer,0.05', brown fine fibrous peat.				
	13	S-6 2.0 0.9					SAND	Gray fine to coarse sand, little to some gravel, trace silt, dense, wet.		31		
	19						14.0					
15	21	S-7 2.0 0.6		G	12.5		GRAVELLY SAND	Gray gravelly fine to coarse sand, trace silt, medium dense, gap graded, wet.		26		
	22											
	54											
	61											
	46											
20	25	S-8 2.0 poor								9		
	17											
	19											
	16											
	23											
25	15	S-9 2.0 0.7								8		
	21											
	23											
	30											
	38											
30	28	S-10 2.0 0.4								8		
	19											
	24							Gray gravelly fine to coarse sand, trace silt, medium dense, gap graded, wet.				
	43						33.0					
	60	S-11 2.0 2.0					SAND	Light brown fine to coarse sand, trace gravel, very loose, well graded, wet.		4		
35	40											
	36						2	Probed from 35.0' to 42.8' with BW drill rods and hollow stem tip. Recorded blow counts per foot - 140 lb hammer dropped 24".				
	53						7					
	73						8					
	90						13					
40	73						51					

U: 3" or 3½" thin wall tube S: split spoon R: rock C: 2" thin wall tube

PRELIMINARY GEOTECHNICAL INVESTIGATION OF ENGINEERING PROPERTIES NEW BEDFORD HARBOR SUPERFUND SITE BRISTOL COUNTY, MASSACHUSETTS

E.C.JORDAN CO.
CONSULTING ENGINEERS

Engineering Log of: BW-109A Page 1/2

Project No. 4959-19

Date Drilled 2/4 - 2/9/88

Sheet A-12

DEPTH (FT.)	CASING BLOWS/FT.	SAMPLE NO. PENETRATION/RECOVERY	SAMPLE	LAB TEST	WATER CONTENT (%)	SHEAR STRENGTH, Su PEAK/RESIDUAL (psf) ROD PROBE (BLOWS/FT.)	SOIL DESCRIPTION	SOIL CLASS	STANDARD PENETRATION RESISTANCE BLOWS/FT 0 10 20 30 40 50 60	PIEZOMETER DATA	ELEV. (FT.)
40	90					72	Grayish brown fine to medium sand, dense to very dense.				
41											
42	175 197					172 62 + 100+	NO PENETRATION				
43		*R-1 5.3/2.5				42.8	BEDROCK AT 42.8 FEET Gray muscovite/biotite gneiss, trace garnet inclusions, some chloritization, schistose, friable.				
44											
45											
						48.1	RQD = 12.3%				
50							BOTTOM OF EXPLORATION AT DEPTH OF 48.1 FEET				
55											
60											
65											
70											
75											
80											

* Rock core obtained with a double barrel N core and NWX core bit.

U: 3" or 3½" thin wall tube S: split spoon R: rock C: 2" thin wall tube

PRELIMINARY GEOTECHNICAL INVESTIGATION
OF ENGINEERING PROPERTIES
NEW BEDFORD HARBOR SUPERFUND SITE
BRISTOL COUNTY, MASSACHUSETTS

E.C.JORDAN CO.
CONSULTING ENGINEERS

Engineering Log of: BW-109A		Page 2/2
Project No. 4959-19	Date Drilled 2/4 - 2/9/88	Sheet A-13

DEPTH (FT.)	CASING BLOWS/FT.	SAMPLE NO. PENETRATION/RECOVERY	SAMPLE	LAB TEST	WATER CONTENT (%)	SHEAR STRENGTH, Su PEAK/RESIDUAL (psf) ROD PROBE (BLOWS/FT.)	SOIL DESCRIPTION	SOIL CLASS	STANDARD PENETRATION RESISTANCE BLOWS/FT 0 10 20 30 40 50 60	PIEZOMETER DATA	ELEV. (FT.)
0											
1							Refer to Boring Log BW-109A for soil descriptions.				
2		U-1 H 2.0 1.3	■								
3			■								
4			■								
5											
8		U-2 H 2.0 0.0	■				No recovery.				
10			■			10.0					
							BOTTOM OF EXPLORATION AT DEPTH OF 10.0 FEET. NO REFUSAL ENCOUNTERED.				
15											
20											
25											
30											
35											
40											

U: 3" or 3½" thin wall tube S: split spoon R: rock C: 2" thin wall tube

PRELIMINARY GEOTECHNICAL INVESTIGATION OF ENGINEERING PROPERTIES
NEW BEDFORD HARBOR SUPERFUND SITE
BRISTOL COUNTY, MASSACHUSETTS

E.C.JORDAN CO.
CONSULTING ENGINEERS

Engineering Log of: BW-109B		
Project No. 4959-19	Date Drilled 2/9/88	Sheet A-14

Depth (ft.)	Casing blows/ft.	Sample no. penetration/recovery	Lab test	Water content (%)	Shear strength, Su peak/residual (psf) rod probe (blows/ft.)	Soil description		Soil class	Standard penetration resistance blows/ft (0 10 20 30 40 50 60)	Piezometer data	Elev. (ft.)
0–1	WOC					ORGANIC SILT	Dark gray silt, some shell fragments.				
1–2	WOC										
2–3	WOC	C-1 H 2.0/1.2	GHASO	88.5 76.7	52/12		Trace to little fine sand, H_2S odor, wet.				
3–4	WOC			87.3	52/12		Some fine sand, very soft.				
4–5	WOM	S-1 2.0/0.3							WOR		
5–6	WOM				92/18						
6–7		C-2 H 2.0/1.5	GHASO	85.6 59.7							
7–8				52.0							
8–9		S-2 2.0/1.7			221/43		Two layers, ≈0.1' to 0.3', fine sandy silt.		WOR		
9–10					166/13	10.0					
10–11		C-3 H 2.0/1.7				SANDY ORGANIC SILT	Dark gray fine sandy silt, trace gravel, very soft, H_2S odor, moist.				
11–12					215/61		Layer, 0.2', silty fine sand.				
12–13		S-3 2.0/2.0							WOR		
13–14											
14–15	WOM	C-4 H 2.0/2.0	GHO	14.0	363 +						
15–16	3					15.3 SAND	Dark gray fine to medium sand, little shell fragments, trace to little silt, very loose, well graded, H_2S odor, moist.				
16–17	3	S-4 2.0/1.3							2		
17–18	4										
18–19	4	S-5 2.0/1.3					Layers of brown peat, moist.		2		
19–20	5						Fine sand, trace medium sand, very loose, faint H_2S odor.				
20–21	8						Some brown peat lenses.				
21–22	12										
22–23	16					23.0					
23–24	21	S-6 2.0/1.4				PEAT	1.1'-1.4' Dark brown peat, some shell fragments, trace sand, very soft, H_2S odor moist.		3		
24–25	21										
25–26	25						0.0'-1.1' Blackish dark brown silty peat, very soft, H_2S odor moist.				
26–27	18										
27–28	18										
28–29	20	C-5 H 2.0/1.8									
29–30	28						Layer, 0.2', gray silt, little fine sand.				
30–31	30	S-7 2.0/2.0					Gray "super" watered silty peat, saturated.		11		
31–32	29					31.5 SAND	Layer, 0.3', gray silt, little fine sand. Gray fine to med. sand, trace silt.				
32–33	39	S-8 2.0/1.5					1.0'-1.5' Gray fine to coarse sand, some silt, trace shell fragments, trace gravel, peat lenses, wet.		12		
33–34	34					34.0					
34–35		S-9 2.0/0.6	G	10.9			0.0'-1.0' Gray fine to medium sand, little coarse sand, trace gravel, medium dense, wet.		33		
35–36											
36–37						24	Gray gravelly fine to coarse sand, trace silt, dense, gap graded.				
37–38						28					
38–39						28	Probed from 36.0' to 62.0' with BW drill rods and hollow stem tip.				
39–40						22					

U: 3" or $3\frac{1}{2}$" thin wall tube S: split spoon R: rock C: 2" thin wall tube

PRELIMINARY GEOTECHNICAL INVESTIGATION
OF ENGINEERING PROPERTIES
NEW BEDFORD HARBOR SUPERFUND SITE
BRISTOL COUNTY, MASSACHUSETTS

E.C.JORDAN CO.
CONSULTING ENGINEERS

Engineering Log of: BW-110		Page 1/2
Project No. 4959-19	Date Drilled 2/9 - 2/10/88	Sheet A-15

DEPTH (FT.)	CASING BLOWS/FT.	SAMPLE NO.	PENETRATION/RECOVERY	SAMPLE	LAB TEST	WATER CONTENT (%)	SHEAR STRENGTH, Su PEAK/RESIDUAL (psf)	ROD PROBE (BLOWS/FT.)	SOIL DESCRIPTION	SOIL CLASS	STANDARD PENETRATION RESISTANCE BLOWS/FT 0 10 20 30 40 50 60	PIEZOMETER DATA	ELEV. (FT.)
40								31	Probed from 36.0' to 62.0' with BW drill rods and hollow stem tip. Recorded blow counts per foot - 140 lb. hammer dropped 30".				
41								16					
42								18					
43								23					
44								39					
45								53					
								45					
								33					
								21					
								14					
50								20					
								14					
								13					
								20					
								14					
55								19					
								18					
								16					
								45					
								102					
60								124					
								274					
								62.0	*REFUSAL SURFACE ENCOUNTERED AT DEPTH OF 62.0 FEET * Refusal of drilling tools and sampling equipment with methods used. Refusal surface is assumed to represent bedrock.				
65													
70													
75													
80													

U: 3" or $3\frac{1}{2}$" thin wall tube S: split spoon R: rock C: 2" thin wall tube

PRELIMINARY GEOTECHNICAL INVESTIGATION OF ENGINEERING PROPERTIES NEW BEDFORD HARBOR SUPERFUND SITE BRISTOL COUNTY, MASSACHUSETTS

E.C.JORDAN CO.
CONSULTING ENGINEERS

Engineering Log of: BW-110		Page 2/2
Project No. 4959-19	Date Drilled 2/9 - 2/10/88	Sheet A-16

DEPTH (FT.)	CASING BLOWS/FT.	SAMPLE NO. PENETRATION/RECOVERY	SAMPLE	LAB TEST	WATER CONTENT (%)	SHEAR STRENGTH, Su PEAK/RESIDUAL (psf) ROD PROBE (BLOWS/FT.)	SOIL DESCRIPTION		SOIL CLASS.	STANDARD PENETRATION RESISTANCE BLOWS/FT	PIEZOMETER DATA	ELEV. (FT.)
0	3						SAND	Brown fine sand, little silt.				
1	5											
2	5	S-1 2.0 1.0		G	18.0			Wet. No silt, medium dense, well graded.		11		
3	7											
4	3	S-2 2.0 0.8		G				Trace coarse sand, trace shell fragments, loose.		10		
5	3											
	3	S-3 2.0 0.9		G D	33.7					4		
	3											
	3	S-4 2.0 1.15						Trace silt, no shell fragments.		10		
	3											
10	3	S-5 2.0 0.9						0.5'-0.9' Some coarse sand, trace medium sand, trace shell fragments, wet. Layer, 0.075', brown silt.		14		
	11											
	4	S-6 2.0 1.7						0.0'-0.4' Brown fine sand, well graded, wet.		17		
	13							Trace coarse sand, medium dense.				
	18	S-7 2.0 1.1						Grayish brown fine sand, trace coarse sand, trace medium sand, medium dense, well graded, wet, brown mottling throughout, layer, 0.15', gray fine sandy silt.		11		
15	25											
	21											
	26											
	23											
	18	S-8 2.0 0.7						Grayish brown fine to coarse sand, little silt, very loose, gap graded, wet.		3		
20	23											
	38							Fine sand, no silt, well graded.				
	43											
	47	S-9 2.0 0.9						Brownish gray fine sand, trace medium sand, trace silt, loose, well graded, wet.		6		
	39											
25	52											
	67											
	54											
	50	S-10 2.0 1.1						0.85'-1.1' Fine to coarse sand, trace gravel Layer, 0.45', brownish gray silty fine sand.		5		
	31							0.0'-0.4' Brownish gray fine sand, trace silt, loose, well graded, wet.				
30	44											
	54											
	68											
	53	S-11 2.0 1.0			18.6			No silt, very loose.		2		
	64											
35	80											
	96											
	107											
	71	S-12 2.0 1.2						Gray fine sand, trace silt, loose, well graded, wet.		5		
	56											
40												

U: 3" or 3½" thin wall tube S: split spoon R: rock C: 2" thin wall tube

PRELIMINARY GEOTECHNICAL INVESTIGATION
OF ENGINEERING PROPERTIES
NEW BEDFORD HARBOR SUPERFUND SITE
BRISTOL COUNTY, MASSACHUSETTS

E.C.JORDAN CO.
CONSULTING ENGINEERS

Engineering Log of: BW-111		Page 1/2
Project No. 4959-19	Date Drilled 1/28 - 2/3/88	Sheet A-17

DEPTH (FT.)	CASING BLOWS/FT.	SAMPLE NO. PENETRATION/RECOVERY	LAB TEST	WATER CONTENT (%)	SHEAR STRENGTH, Su PEAK/RESIDUAL (psf) ROD PROBE (BLOWS/FT.)	SOIL DESCRIPTION	SOIL CLASS.	STANDARD PENETRATION RESISTANCE BLOWS/FT 0 10 20 30 40 50 60	PIEZOMETER DATA	ELEV. (FT.)
40										
41	78									
42	102									
43	110									
44	83	S-13 2.0 1.6				Layer, 1.0', gray silty fine sand. Gray fine sand, loose, well graded, wet.		4		
45	97									
	110									
	122									
	136									
	95	S-14 2.0 1.2	G	29.6		Layer, >1.2', gray silty fine sand.		5		
50	116									
	73									
	62									
	83									
	127	S-15 2.0 1.5				Little to some silt, medium dense, well graded.		11		
55	98									
	114									
	117									
	125									
	x	S-16 2.0 0.7				Layer, 0.25', gray fine to coarse sand, trace gravel, trace silt, medium dense, well graded.		16		
60	x									
	x									
	x									
	x									
	33	R-1				*Casing refusal, cored through large cobble.* Telescoped casing from 4.0" nominal steel casing to 3.0" nominal to continue advancement of the borehole.				
65	18									
	27									
	43									
	50									
	63	S-17 1.0 0.4				Brown fine to medium sand, some gravel, trace coarse sand, trace silt, very dense, wet.				
70	49									
	54									
	58									
	48					73.0'				
		*R-2 1.75 1.3				BEDROCK AT 73.0 FEET 74.75 Gray fine grained muscovite gneiss, few garnet inclusions, thin foliations (¼" to 1"), trace chloritization. RQD = 0.0%				
75										
80										

BOTTOM OF EXPLORATION AT DEPTH OF 74.75 FEET

* Rock core obtained with a single barrel B core and BWX core bit.

U: 3" or 3½" thin wall tube S: split spoon R: rock C: 2" thin wall tube

PRELIMINARY GEOTECHNICAL INVESTIGATION
OF ENGINEERING PROPERTIES
NEW BEDFORD HARBOR SUPERFUND SITE
BRISTOL COUNTY, MASSACHUSETTS

E.C.JORDAN CO.
CONSULTING ENGINEERS

Engineering Log of: BW-111		Page 2/2
Project No. 4959-19	Date Drilled 1/28 - 2/3/88	Sheet A-18

Depth (ft.)	Casing Blows/Ft.	Sample No. Penetration/Recovery	Sample	Lab Test	Water Content (%)	Shear Strength, Su Peak/Residual (psf) Rod Probe (Blows/Ft.)	Soil Description		Soil Class	Standard Penetration Resistance Blows/Ft	Piezometer Data	Elev. (Ft.)
0	WOC						ORGANIC SILT	Dark gray organic silt, some shell fragments, H_2S odor.				
1	WOC					110/15		Trace shell fragments, very soft, wet.				
2	WOC	S-1 2.0/0.9	☒	G H O	38.0		2.5			WOM		
3	WOC		☒				SILTY SAND	Dark gray silty fine sand, trace medium sand, very loose, H_2S odor, wet.				
4	WOM	S-2 2.0/0.0	☒					No recovery		WOM		
5	WOM		☒				6.0					
	1	S-3 2.0/0.4	☒	G	22.6		SAND	Dark brown fine to coarse sand, trace silt, very loose, wet.		4		
	4		☒					Layer, <0.1', peat.				
	12	S-4 2.0/1.0	☒					Brown fine sand, little medium sand, trace coarse sand, medium dense, wet.		29		
	19		☒					Trace medium sand, trace gravel, trace silt, very dense, little mottling.				
10	22	S-5 2.0/1.0	☒							55		
	22		☒									
	12	S-6 2.0/0.85	☒					Brownish gray fine sand, little gravel, trace coarse sand, trace medium sand, dense, wet.		46		
	21		☒									
	18	S-7 2.0/0.7	☒					Little to some gravel, gap graded.		32		
15	30		☒									
	34											
	53											
	35											
	9	S-8 2.0/1.0	☒	G	17.6			Some gravel, little coarse sand, loose.		8		
20	13		☒									
	26											
	38											
	13	S-9 2.0/1.65	☒					Grayish brown fine to medium sand, some gravel, trace coarse sand, loose, wet.		6		
	14		☒									
25	32											
	56											
	64											
	23	S-10 2.0/1.2	☒	G	17.6			Little coarse sand.		7		
	28		☒									
30	53											
	53											
	55							0.4'-0.7' Grayish brown coarse sand, little gravel, trace med. sand, trace fine sand, medium dense.				
	x	S-11 2.0/0.7	☒				34.0			7		
	x		☒				SILTY SAND (Glacial Till)	0.0'-0.4' Gray silty fine sand, little to some gravel, little coarse sand, trace medium sand, trace clay, medium dense, wet.				
35												
							42	Probed from 35.0' to 42.8' with BW drill rods and hollow stem tip. Recorded blow counts per foot - 140 lb. hammer dropped 24".				
							42					
							29					
							53					
40												

U: 3" or 3½" thin wall tube S: split spoon R: rock C: 2" thin wall tube

PRELIMINARY GEOTECHNICAL INVESTIGATION OF ENGINEERING PROPERTIES
NEW BEDFORD HARBOR SUPERFUND SITE
BRISTOL COUNTY, MASSACHUSETTS

E.C.JORDAN CO.
CONSULTING ENGINEERS

Engineering Log of: BW-112		Page 1/2
Project No. 4959-19	Date Drilled 2/3/88	Sheet A-19

DEPTH (FT.)	CASING BLOWS/FT.	SAMPLE NO. PENETRATION/RECOVERY	SAMPLE	LAB TEST	WATER CONTENT (%)	SHEAR STRENGTH, Su PEAK/RESIDUAL (psf)	ROD PROBE (BLOWS/FT.)	SOIL DESCRIPTION	SOIL CLASS.	STANDARD PENETRATION RESISTANCE BLOWS/FT 0 10 20 30 40 50 60	PIEZOMETER DATA	ELEV. (FT.)
40							110					
41							183	NO PENETRATION				
42							100+					
43							42.8	*REFUSAL SURFACE ENCOUNTERED AT DEPTH OF 42.8 FEET				
44												
45								* Refusal of drilling tools and sampling equipment with methods used. Refusal surface is assumed to represent bedrock.				
50												
55												
60												
65												
70												
75												
80												

U: 3" or 3½" thin wall tube S: split spoon R: rock C: 2" thin wall tube

PRELIMINARY GEOTECHNICAL INVESTIGATION
OF ENGINEERING PROPERTIES
NEW BEDFORD HARBOR SUPERFUND SITE
BRISTOL COUNTY, MASSACHUSETTS

E.C.JORDAN CO.
CONSULTING ENGINEERS

Engineering Log of: BW-112		Page 2/2
Project No. 4959-19	Date Drilled 2/3/88	Sheet A-20

DEPTH (FT.)	CASING BLOWS/FT.	SAMPLE NO. PENETRATION/RECOVERY	SAMPLE	LAB TEST	WATER CONTENT (%)	SHEAR STRENGTH, Su PEAK/RESIDUAL (psf) ROD PROBE (BLOWS/FT.)	SOIL DESCRIPTION	SOIL CLASS	STANDARD PENETRATION RESISTANCE BLOWS/FT 0 10 20 30 40 50 60	PIEZOMETER DATA	ELEV. (FT.)
0						1	Probed from 0.0' to 20.4' with BW drill rods and hollow stem tip. Recorded blow counts per foot - 140 lb. hammer dropped 18".				
1						1					
2						2					
3						8					
4						21					
5						26					
						28					
						35					
						46					
						78					
10						53					
						55					
						70					
						74					
						68					
15						62					
						143					
						113					
						123					
						80					
20						100+	NO PENETRATION				
						20.4	*REFUSAL SURFACE ENCOUNTERED AT DEPTH OF 20.4 FEET				
							* Refusal of drilling tools and sampling equipment with methods used. Refusal surface is assumed to represent bedrock.				
25											
30											
35											
40											

U: 3" or 3½" thin wall tube S: split spoon R: rock C: 2" thin wall tube

PRELIMINARY GEOTECHNICAL INVESTIGATION OF ENGINEERING PROPERTIES NEW BEDFORD HARBOR SUPERFUND SITE BRISTOL COUNTY, MASSACHUSETTS

E.C.JORDAN CO.
CONSULTING ENGINEERS

Engineering Log of: PW-102		
Project No. 4959-19	Date Drilled 1/13/88	Sheet A-21

DEPTH (FT.) | CASING BLOWS/FT. | SAMPLE NO. PENETRATION/RECOVERY | SAMPLE | LAB TEST | WATER CONTENT (%) | SHEAR STRENGTH, Su PEAK/RESIDUAL (psf) | ROD PROBE (BLOWS/FT.) | SOIL DESCRIPTION | SOIL CLASS | STANDARD PENETRATION RESISTANCE BLOWS/FT 0 10 20 30 40 50 60 | PIEZOMETER DATA | ELEV. (FT.)

DEPTH (FT.)	ROD PROBE (BLOWS/FT.)	SOIL DESCRIPTION
0	5	Probed from 0.0' to 20.6' with BW drill rods and hollow stem tip. Recorded blow counts per foot - 140 lb. hammer dropped 30".
1	5	
2	2	
3	2	
4	3	
5	59	
	28	
	24	
	25	
	18	
10	27	
	25	
	26	
	22	
	25	
15	52	
	53	
	34	
	28	
	51	
20	100+	NO PENETRATION
	20.6	*REFUSAL SURFACE ENCOUNTERED AT DEPTH OF 20.6 FEET
25		* Refusal of drilling tools and sampling equipment with methods used. Refusal surface is assumed to represent bedrock.
30		
35		
40		

U: 3" or 3½" thin wall tube S: split spoon R: rock C: 2" thin wall tube

PRELIMINARY GEOTECHNICAL INVESTIGATION OF ENGINEERING PROPERTIES NEW BEDFORD HARBOR SUPERFUND SITE BRISTOL COUNTY, MASSACHUSETTS

E.C.JORDAN CO.
CONSULTING ENGINEERS

Engineering Log of: PW-103

Project No.	Date Drilled	
4959-19	1/20/88	Sheet A-22

DEPTH (FT.)	CASING BLOWS/FT.	SAMPLE NO. PENETRATION/RECOVERY	SAMPLE	LAB TEST	WATER CONTENT (%)	SHEAR STRENGTH, Su PEAK/RESIDUAL (psf) ROD PROBE (BLOWS/FT.)	SOIL DESCRIPTION		SOIL CLASS	STANDARD PENETRATION RESISTANCE BLOWS/FT	PIEZOMETER DATA	ELEV. (FT.)
0	Hollow Stem Auger						SAND (Fill)	Black fine to medium sand, little silt, trace gravel.			Bentonite Seal	
2		S-1 2.0/1.2						Brown fine to medium sand, little gravel, trace coarse sand, trace silt, medium dense, moist to wet.		12	1.0" ID Sch. 40 PVC Pipe	
4		S-2 2.0/1.2						Wet.		13		
6		S-3 2.0/1.0					6.0 ASH FILL	Black ash, little fine to coarse sand, trace gravel, trace silt, very loose, wet.		2	Cuttings and Cave-in	
8		S-4 2.0/1.0					9.0 SAND	Brown fine to medium sand, trace gravel, trace coarse sand, trace silt, loose, wet.		6		
10	6	S-5 2.0/1.0								3		
11	3											
12	7	S-6 2.0/1.2		G	6.1		12.0 SANDY SILT	Dark gray fine to coarse sandy silt, trace gravel, trace clay, trace shell fragments, very soft.		2		
13	4											
14	12	S-7 2.0/1.0					14.0 SILTY SAND	Dark gray silty fine to coarse sand, little gravel, trace shell fragments, medium dense, wet.		20	Bentonite Seal	14.0
15	61						15.5 GRAVELLY SAND	Brown gravelly fine to coarse sand, little silt, trace cobble, wet.				15.0
16	x										Filter Sand	
17	x										Slotted Pipe	17.0
18	x											
19	x											
20	54	S-8 2.0/1.5					20.0 SAND	Brown fine to medium sand, little gravel, little silt, trace coarse sand, very dense, wet.		147		
21	141											
22	79											22.0
23.3		*R-1 5.0/4.8					23.3	BEDROCK AT 23.3 FEET Gray to pink fine grained qneissic granite, trace garnet inclusions, massive to lightly fractured. RQD = 72.0%				
28.3							28.3	BOTTOM OF EXPLORATION AT 28.3 FEET				28.3

* Rock core obtained with a double barrel N core and NWX core bit.

U: 3" or $3\frac{1}{2}$" thin wall tube   S: split spoon   R: rock   C: 2" thin wall tube

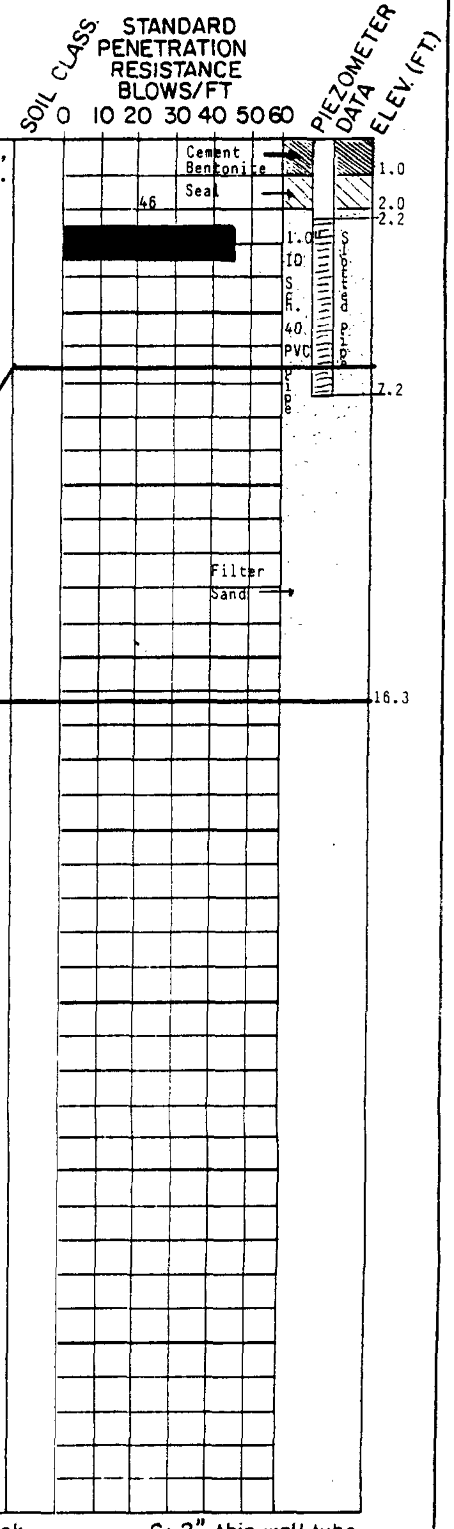
PRELIMINARY GEOTECHNICAL INVESTIGATION
OF ENGINEERING PROPERTIES
NEW BEDFORD HARBOR SUPERFUND SITE
BRISTOL COUNTY, MASSACHUSETTS

E.C.JORDAN CO.
CONSULTING ENGINEERS

Engineering Log of:	BL-101
Project No.	4959-19
Date Drilled	1/18/88
	Sheet A-23

DEPTH (FT.)	CASING BLOWS/FT.	SAMPLE NO. PENETRATION/RECOVERY	SAMPLE	LAB TEST	WATER CONTENT (%)	SHEAR STRENGTH, Su PEAK/RESIDUAL (psf) ROD PROBE (BLOWS/FT.)	SOIL DESCRIPTION
0	Hollow Stem Auger					SAND	Black and brown fine to coarse sand, little gravel, little silt, moist.
2		S-1 2.0/0.3					Dense.
4		S-2 2.0/1.2					Layer, 0.4', brown silty fine to medium sand, trace gravel and coarse sand. 0.0'-0.8' Tannish brown fine to coarse sand, trace gravel, trace silt, wet.
6		S-3				6.3	Brown silty fine sand, little gravel, wet.
		*R-1 5.0/4.9					BEDROCK AT 6.3 FEET Gray gneissic granite, some muscovite, fractured with some iron staining along fractures. RQD = 98.0% for R-1 RQD = 84.0% for R-2
11		*R-2 5.0/4.2					
16.3						16.3	BOTTOM OF EXPLORATION AT 16.3 FEET

* Rock core obtained with a double barrel N core and NWX core bit.



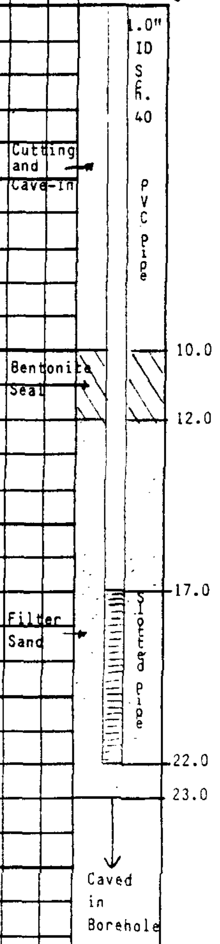
U: 3" or 3½" thin wall tube S: split spoon R: rock C: 2" thin wall tube

PRELIMINARY GEOTECHNICAL INVESTIGATION
OF ENGINEERING PROPERTIES
NEW BEDFORD HARBOR SUPERFUND SITE
BRISTOL COUNTY, MASSACHUSETTS

E.C.JORDAN CO.
CONSULTING ENGINEERS

Engineering Log of: BL-102		
Project No. 4959-19	Date Drilled 1/22/88	Sheet A-24

Depth (ft.)	Casing blows/ft.	Sample No. Penetration/Recovery	Sample	Lab test	Water content (%)	Shear strength, Su Peak/Residual (psf) Rod probe (blows/ft.)	Soil description	Soil class	Standard penetration resistance blows/ft
0	Hollow Stem Auger						SAND Gray fine to medium sand, trace gravel, trace coarse sand, trace silt, moist.		
1									
2		S-1 2.0/0.9	☒				Medium dense.		14
3			☒						
4		S-2 2.0/0.8	☒	G	11.0		Some silt.		15
5			☒						
		S-3 2.0/0.7	☒				Layer of gray silty fine to medium sand, trace gravel, trace coarse sand, medium dense, wet.		9
			☒						
		S-4 2.0/0.7	☒				Gray-black fine to coarse sand, trace gravel, trace silt, trace roots, loose, wet.		10
			☒						
10	x	S-5 2.0/0.9	☒				Gray fine to medium sand, little silt, trace gravel, trace coarse sand, loose, wet.		6
	x		☒						
	8	S-6 2.0/0.3	☒				Gray fine to coarse sand, trace gravel, trace silt, very loose, wet.		3
	3		☒						
	8	S-7 2.0/0.5	☒	G	56.9		Layer of dark gray organic silt, little fine sand, trace shell fragments, soft, wet, H_2S odor.		2
15	7		☒						
	7								
	8								
	11								
	8								
20	23	S-8 2.0/1.7	☒				Layer, 0.7', dark brown peat, highly decomposed. 0.0'-1.0' Olive fine to medium sand, trace coarse sand, trace silt, medium dense, wet.		23
	24		☒						
	26								
	62								
	119								
25	34	S-9 2.0/0.9	☒				Gray fine to medium sand, little to trace silt, trace coarse sand, medium dense, wet.		13
	43		☒						
	63								
	58								
	69								
30	42	S-10 2.0/1.1	☒				Light gray fine to medium sand, some silt, trace gravel, trace coarse sand, trace clay, dense, wet.		47
	56		☒						
	75								
	59								
	47								
35	42	S-11 2.0/1.2	☒						40
	50		☒						
	58								
	48								
	49								
40									



U: 3" or 3½" thin wall tube S: split spoon R: rock C: 2" thin wall tube

PRELIMINARY GEOTECHNICAL INVESTIGATION OF ENGINEERING PROPERTIES NEW BEDFORD HARBOR SUPERFUND SITE BRISTOL COUNTY, MASSACHUSETTS

E.C.JORDAN CO.
CONSULTING ENGINEERS

Engineering Log of: BL-103		Page 1/2
Project No. 4959-19	Date Drilled 1/19-1/20/88	Sheet A-25

DEPTH (FT.)	CASING BLOWS/FT.	SAMPLE NO. PENETRATION/RECOVERY	SAMPLE	LAB TEST	WATER CONTENT (%)	SHEAR STRENGTH, Su PEAK/RESIDUAL (psf) ROD PROBE (BLOWS/FT.)	SOIL DESCRIPTION	SOIL CLASS	STANDARD PENETRATION RESISTANCE BLOWS/FT 0 10 20 30 40 50 60	PIEZOMETER DATA	ELEV. (FT.)
40	35	S-12 2.0 1.2	☒				Layer of light gray silty sand, little gravel, trace coarse sand, trace clay, dense, wet.		35		
41	36										
42	43										
43	65										
44	71										
45	53	S-13 1.4 0.4	☒				Light brown fine to coarse sand, some silt, little gravel, little clay, very dense, wet.		68+ (100)#		
	79	R-1					Granite boulder.				
	x						#No penetration after 100 blows.				
	x										
	38										
50	x	S-14 2.0 1.3	☒				Trace gravel, trace clay, medium dense, wet.		12		
	x					52.3					
		*R-2 5.0 4.9					BEDROCK AT 52.3 FEET Gray to pink fine grained gneissic granite, one pegmatite string predominately feldspar and quartz (very large crystals) approximately 1.0 foot thick. RQD = 98.0%				
55						57.3					
							BOTTOM OF EXPLORATION AT 57.3 FEET				
60											
65											
70											
75											
80											

*Rock core obtained with double barrel N core and NWX core bit.

x Casing blows/ft. not recorded.

U: 3" or 3½" thin wall tube S: split spoon R: rock C: 2" thin wall tube

PRELIMINARY GEOTECHNICAL INVESTIGATION
OF ENGINEERING PROPERTIES
NEW BEDFORD HARBOR SUPERFUND SITE
BRISTOL COUNTY, MASSACHUSETTS

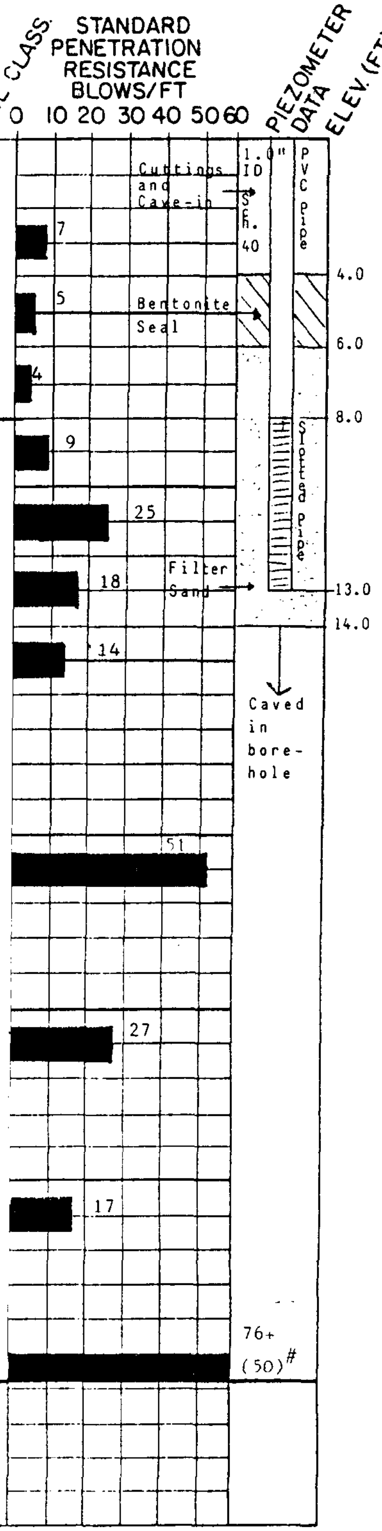
E.C.JORDAN CO.
CONSULTING ENGINEERS

Engineering Log of: BL-103		Page 2/2
Project No. 4959-19	Date Drilled 1/19-1/20/88	Sheet A-26

Depth (ft.)	Casing Blows/Ft.	Sample No. Penetration/Recovery	Sample	Lab Test	Water Content (%)	Shear Strength, Su Peak/Residual (psf) Rod Probe (Blows/Ft.)	Soil Class	Soil Description
0–2	Hollow Stem Auger (to 10)						SILTY SAND	Black silty fine to medium sand, little coarse sand, trace gravel, moist. Wet.
2–4		S-1 2.0/1.2	☒					Layer, 0.8', brown fine to medium sand, some silt, trace gravel, trace coarse sand, wet.
4–6		S-2 2.0/0.5	☒					Brown, trace coarse sand, loose, wet. Layer, 0.4', light brown clayey silt, little fine sand, soft, wet.
6–8		S-3 2.0/1.4	☒	G	22.3			Little coarse sand. 0.0-0.4' Olive fine to med.sand, little clay, med. dense, wet.
8.0							SAND	
8–10		S-4 2.0/0.4	☒		20.4			Grayish olive fine to coarse sand, some silt, trace gravel, loose, wet.
10–12	12 5	S-5 2.0/0.0	☒					No recovery.
12–14	10 7	S-6 2.0/1.0	☒					Gray fine sand, little gravel, little coarse sand, little medium sand, little silt, medium dense, wet.
14–16	10 80	S-7 2.0/0.1	☒					Black fine to coarse sand, some gravel, some silt, medium dense, wet.
16–20	11 15 13 16							
20–22	34 37	S-8 2.0/1.2	☒	G	14.1			Gray fine to med. sand, trace silt, trace coarse sand, trace gravel, very dense. Brown fine sand, little medium sand, trace silt, very dense, wet.
22–25	36 46 53							
25–27	37 43	S-9 2.0/1.4	☒					Layer, 0.55', brown fine silty sand, wet. Brown fine to coarse sand, trace silt, wet.
27–30	33 46 44							
30–32	45 36	S-10 2.0/0.8	☒					Gray, little gravel, medium dense, wet. #No penetration after 50 blows.
32–35	68 74 78							
35–35.7		S-11 0.7/[illegible]	☒				35.7	Light brown fine to medium sand, some silt, trace gravel, trace coarse sand, trace clay, med. dense, wet.

*REFUSAL SURFACE ENCOUNTERED AT DEPTH OF 35.7 FEET

*Refusal of drilling tools and sampling equipment with methods used. Refusal surface is believed to represent bedrock.



U: 3" or 3½" thin wall tube S: split spoon R: rock C: 2" thin wall tube

PRELIMINARY GEOTECHNICAL INVESTIGATION OF ENGINEERING PROPERTIES NEW BEDFORD HARBOR SUPERFUND SITE BRISTOL COUNTY, MASSACHUSETTS

E.C.JORDAN CO.
CONSULTING ENGINEERS

Engineering Log of:	BL-104
Project No.	4959-19
Date Drilled	1/21-1/22/88
	Sheet A-27

Depth (ft.)	Casing blows/ft.	Sample no. Penetration/Recovery	Sample	Lab test	Water content (%)	Shear strength, Su Peak/Residual (psf) Rod probe (blows/ft.)	Soil description		Soil class	Standard penetration resistance blows/ft	Piezometer data	Elev. (ft.)
0	Hollow Stem Auger						GRAVEL	Gravel Parking Area			Cement	Protective Road Block
1							SAND (Fill)	Brown fine to medium sand, little gravel, trace coarse sand, trace silt, loose, moist.				
2–3		S-1 2.0/1.5								10		
4–5		S-2 2.0/1.0						Trace gravel, moist. Wet.		9		
6–7		S-3 2.0/1.3		G	21.4					8	Cuttings and Cave-in	
8–9		S-4 2.0/1.4					9.0			11	1.0" ID Schedule 40 PVC pipe	
10	5 8	S-5 2.0/1.2					SAND (Native)	Grayish brown fine to medium sand, trace gravel, trace coarse sand, trace silt, medium dense, wet.		6		
12	6 15	S-6 2.0/1.2					12.0 GRAVELLY SAND	Gray gravelly fine to coarse sand, little silt.		17		
14	14	S-7								160		
15	Spun 3.0" Casing	R-1						Boulder from 14.5' – 15.5' Layer, gray fine to coarse sand, some cobble, some gravel, little silt, boulders or cobbles encountered.				
20		S-8 2.0/1.0						Boulders or cobbles encountered, very dense, wet.		52		
24											Bentonite Seal	24.0
25	16 16	S-9 2.0/0.0						No recovery.		26		25.0
27	5 10	S-10 2.0/0.2						Gray gravelly fine to coarse sand, trace silt, medium dense, wet.		17		
30	29 40 37	S-11 2.0/0.7						Little silt, boulders or cobbles encountered, medium dense, wet.		30	Filter Sand Slotted pipe	30.0
32	42 29 36							#No penetration after 100 blows.				
35	30 25	S-12 1.3/1.3					34.7 SAND 36.0	Gray fine to medium sand, little silt, trace coarse sand, trace gravel, medium dense, wet.		119# (100)#		35.0
36–40		*R-2 5.2/4.6						BEDROCK AT 36.0 FEET Gray to light pink gneissic granite, massive. RQD = 88.5%				

U: 3" or 3½" thin wall tube S: split spoon R: rock C: 2" thin wall tube

PRELIMINARY GEOTECHNICAL INVESTIGATION OF ENGINEERING PROPERTIES
NEW BEDFORD HARBOR SUPERFUND SITE
BRISTOL COUNTY, MASSACHUSETTS

E.C.JORDAN CO.
CONSULTING ENGINEERS

Engineering Log of: BL-105		Page 1/2
Project No. 4959-19	Date Drilled 1/12-1/13/88	Sheet A-28

DEPTH (FT.)	CASING BLOWS/FT.	SAMPLE NO. PENETRATION/RECOVERY	SAMPLE	LAB. TEST	WATER CONTENT (%)	SHEAR STRENGTH, Su PEAK/RESIDUAL (psf) ROD PROBE (BLOWS/FT.)	SOIL DESCRIPTION	SOIL CLASS	STANDARD PENETRATION RESISTANCE BLOWS/FT 0 10 20 30 40 50 60	PIEZOMETER DATA	ELEV. (FT.)
40		*R-2									
41							41.2				
42							BOTTOM OF EXPLORATION AT 41.2 FEET				
43											
44											
45							* Rock core obtained with a single barrel B core and BWX core bit.				
50											
55											
60											
65											
70											
75											
80											

U: 3" or 3½" thin wall tube S: split spoon R: rock C: 2" thin wall tube

PRELIMINARY GEOTECHNICAL INVESTIGATION
OF ENGINEERING PROPERTIES
NEW BEDFORD HARBOR SUPERFUND SITE
BRISTOL COUNTY, MASSACHUSETTS

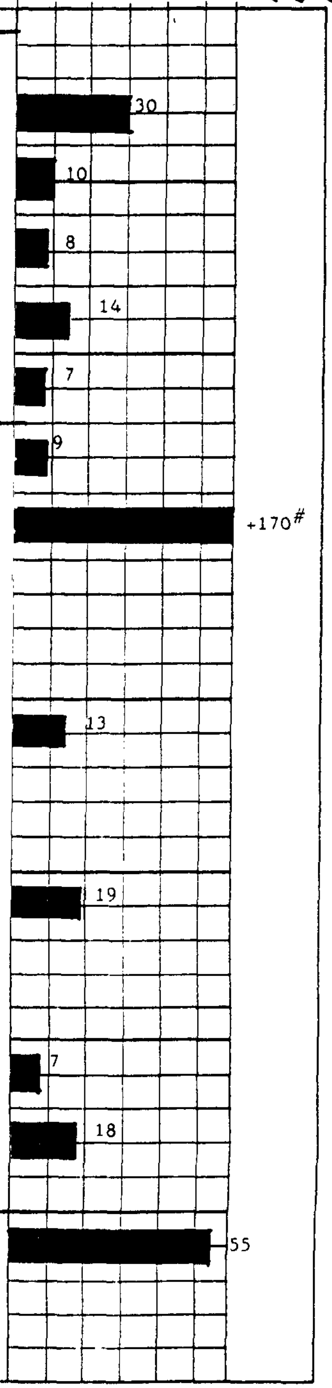
E.C.JORDAN CO.
CONSULTING ENGINEERS

Engineering Log of: BL-105		Page 2/2
Project No. 4959-19	Date Drilled 1/12-1/13/88	Sheet A-29

DEPTH (FT.)	SAMPLE NO. PENETRATION/RECOVERY	SAMPLE LAB TEST	WATER CONTENT (%)	SHEAR STRENGTH, Su PEAK/RESIDUAL (psf) ROD PROBE (BLOWS/FT.)	SOIL DESCRIPTION		SOIL CLASS	STANDARD PENETRATION RESISTANCE BLOWS/FT	PIEZOMETER DATA	ELEV. (FT.)
0					GRAVEL	Gravel Parking Area				
2.0–4.0	S-1 2.0/0.8				SAND (Fill)	Brown fine to medium sand, little gravel, little to trace silt, trace coarse sand, trace cobble, trace brick and ashes, medium dense, moist.		30		
4.0–6.0	S-2 2.0/0.65					Some to little gravel, loose, wet.		10		
6.0–8.0	S-3 2.0/0.4	G	39.0			Some gravel.		8		
8.0–10.0	S-4 2.0/0.1					Dark brown gravelly sand, trace organics, medium dense.		14		
10.0–12.0	S-5 2.0/1.0					Trace ash and cinders, loose.		7		
12.0										
12.0–14.0	S-6 2.0/1.8				SAND (Native)	Layer, 1.0', black silty fine to medium sand, trace coarse sand and gravel.		9		
14.0–16.0	S-7 2.0/1.6	G	34.1			Gray fine to coarse sand, trace gravel, trace silt, medium dense, wet. #Split spoon binding against auger.		+170#		
20.0–22.0	S-8 2.0/0.6					Brown fine to coarse sand, trace silt, trace gravel, medium dense, wet, well graded.		13		
25.0–26.5	S-9 1.5/0.8					Brown fine to medium sand, trace coarse sand, trace gravel, medium dense, wet.		19		
30.0–32.0	S-10 2.0/0.2							7		
32.0–34.0	S-11 2.0/0.8							18		
35.0										
35.0–37.0	S-12 2.0/0.5				GRAVELLY SAND	Brown gravelly fine to coarse sand, little silt, trace cobble, very dense, wet.		55		

CASING BLOWS/FT.: Hollow Stem Auger (0–20)

DEPTH (FT.)	CASING BLOWS/FT.
20	10
21	11
22	14
23	20
24	24
25	8
26	13
27	15
28	31
29	43
30	18
31	24
32	15
33	14
34	44
35	20
36	63
37	47
38	32
39	53



U: 3" or 3½" thin wall tube S: split spoon R: rock C: 2" thin wall tube

PRELIMINARY GEOTECHNICAL INVESTIGATION
OF ENGINEERING PROPERTIES
NEW BEDFORD HARBOR SUPERFUND SITE
BRISTOL COUNTY, MASSACHUSETTS

E.C.JORDAN CO.
CONSULTING ENGINEERS

Engineering Log of: BL-106		Page 1/2
Project No. 4959-19	Date Drilled 1/7-1/11/88	Sheet A-30

DEPTH (FT.)	CASING BLOWS/FT.	SAMPLE NO. PENETRATION/RECOVERY	SAMPLE	LAB TEST	WATER CONTENT (%)	SHEAR STRENGTH, Su PEAK/RESIDUAL (psf) ROD PROBE (BLOWS/FT.)	SOIL DESCRIPTION	SOIL CLASS	STANDARD PENETRATION RESISTANCE BLOWS/FT 0 10 20 30 40 50 60	PIEZOMETER DATA	ELEV. (FT.)
40		S-13					Layers, 0.25', brown fine sandy silt layers.				
41	11	2.0/0.8							36		
42	30										
43	40						#No penetration after 100 blows.				
44	33										
45	43										
	42+	S-14					SAND Brown fine to medium sand, little gravel, little silt.		130+		
		*R-1					45.7 BEDROCK AT 45.7 FEET		(100)#		
		5.2/5.0					Gray to light pink gneissic granite, some muscovite, massive.				
							RQD = 96.2%				
50							50.9				
							BOTTOM OF EXPLORATION AT 50.9 FEET				
							*Rock core obtained with a double barrel N core and NWX core bit.				
55											
60											
65											
70											
75											
80											

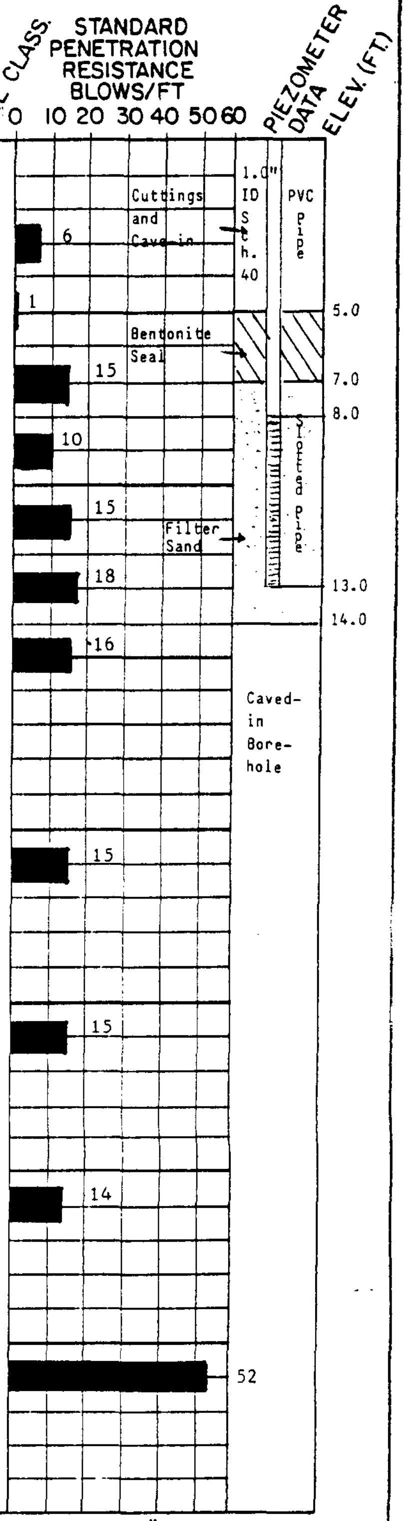
U: 3" or 3½" thin wall tube S: split spoon R: rock C: 2" thin wall tube

PRELIMINARY GEOTECHNICAL INVESTIGATION
OF ENGINEERING PROPERTIES
NEW BEDFORD HARBOR SUPERFUND SITE
BRISTOL COUNTY, MASSACHUSETTS

E.C.JORDAN CO.
CONSULTING ENGINEERS

Engineering Log of: BL-106		Page 2/2
Project No. 4959-19	Date Drilled 1/7-1/11/88	Sheet A-31

Depth (Ft.)	Casing Blows/Ft.	Sample No. Penetration/Recovery	Lab Test	Water Content (%)	Shear Strength, Su Peak/Residual (psf) Rod Probe (Blows/Ft.)	Soil Description	Soil Class	Standard Penetration Resistance Blows/Ft
0	Hollow Stem Auger					SAND		
1								
2		S-1 2.0/0.9				0.7'-0.9' Green fine to medium sand, trace silt, loose, wet. 0.0'-0.7' Tan fine to medium sand, little coarse sand, trace silt and roots.		6
3								
4		S-2 2.0/1.5				Brown, no roots. Layer, 0.4', gray silt, some fine sand, some organics, soft, wet.		1
5						Layer, 0.7', brown humus, some silt, fine sand, firm, wet.		
6		S-3 2.0/1.0						15
7						Olive-brown fine sand, little medium sand, little roots, medium dense, wet.		
8		S-4 2.0/1.6				Layer, 0.7', black organics, some silt, fibrous, soft, wet.		10
9						Brown fine sand, trace silt, trace roots, loose, wet.		
10	WOM	S-5 2.0/1.5						15
11	WOM							
12	12	S-6 2.0/1.1	G	39.5		Olive fine sand, trace silt, loose, wet.		18
13	13							
14	8	S-7 2.0/1.2				Gray fine to medium sand, little coarse sand, trace silt, medium dense, wet.		16
15	8							
16	16							
17	24							
18	25							
19	23							
20	13	S-8 2.0/0.7	G D	18.2		Tannish brown.		15
21	20							
22	30							
23	28							
24	29							
25	14	S-9 2.0/0.6				Trace gravel.		15
26	17							
27	31							
28	55							
29	88							
30	42	S-10 2.0/1.0				Grayish olive.		14
31	36							
32	34							
33	39							
34	40							
35	57	S-11 2.0/1.5				Layer, 1.5', olive fine sandy silt, trace gravel, trace medium sand, trace clay, very dense, wet.		52
36	27							
37	34	R-1				Granite boulder, 0.9' thick.		
38	29							
39	41							
40								



U: 3" or 3½" thin wall tube S: split spoon R: rock C: 2" thin wall tube

PRELIMINARY GEOTECHNICAL INVESTIGATION
OF ENGINEERING PROPERTIES
NEW BEDFORD HARBOR SUPERFUND SITE
BRISTOL COUNTY, MASSACHUSETTS

E.C.JORDAN CO.
CONSULTING ENGINEERS

Engineering Log of:	BL-107	Page 1/2
Project No. 4959-19	Date Drilled 1/26-1.28/88	Sheet A-32

DEPTH (FT.)	CASING BLOWS/FT.	SAMPLE NO. PENETRATION/RECOVERY	SAMPLE	LAB TEST	WATER CONTENT (%)	SHEAR STRENGTH, Su PEAK/RESIDUAL (psf) ROD PROBE (BLOWS/FT.)	SOIL DESCRIPTION	SOIL CLASS	STANDARD PENETRATION RESISTANCE BLOWS/FT 0 10 20 30 40 50 60	PIEZOMETER DATA	ELEV. (FT.)
40	57	R-1 5.0/0.9									
41	84										
42	73						Wash contained coarse sand.				
43	106										
44	102										
45	38	S-12					Brown fine sand, trace silt. Standard penetration resistance not recorded.				
	74										
	78										
		*R-2					Boulders.				
50											
						53.6	BEDROCK AT 53.6 FEET				
		2.4/2.0					Gray biotite/muscovite gneiss, some chloritization, trace garnet inclusions, schistose, friable, pegmatite string predominately feldsphar and quartz (very large crystals) approximately 1.0 foot thick.				
55											
						56.0	RQD = 41.7%				
60							BOTTOM OF EXPLORATION AT 56.0 FEET				
							*Rock core obtained with a double barrel N core and NWX core bit.				
65											
70											
75											
80											

U: 3" or $3\frac{1}{2}$" thin wall tube S: split spoon R: rock C: 2" thin wall tube

PRELIMINARY GEOTECHNICAL INVESTIGATION OF ENGINEERING PROPERTIES
NEW BEDFORD HARBOR SUPERFUND SITE
BRISTOL COUNTY, MASSACHUSETTS

E.C.JORDAN CO.
CONSULTING ENGINEERS

Engineering Log of: BL-107 Page 2/2

Project No. 4959-19
Date Drilled 1/26-1/28/88
Sheet A-33

DEPTH (FT.)	CASING BLOWS/FT.	SAMPLE NO. PENETRATION/RECOVERY	SAMPLE	LAB TEST	WATER CONTENT (%)	SHEAR STRENGTH, Su PEAK/RESIDUAL (psf)	ROD PROBE (BLOWS/FT.)	SOIL DESCRIPTION	SOIL CLASS	STANDARD PENETRATION RESISTANCE BLOWS/FT 0 10 20 30 40 50 60	PIEZOMETER DATA	ELEV. (FT.)
0	Hollow Stem Auger							SAND Brown fine to medium sand, little coarse sand, little silt, very loose.				
2		S-1 2.0/1.5	☒	G	19.6					4		
3								Lense - brown silt.				
4		S-2 2.0/1.2	☒					Gray, some silt, trace shell fragments, no coarse sand.		3		
6		S-3 2.0/1.1	☒					Layer, 0.7', gray clayey silt, trace fine sand, trace shell fragments, trace roots, very soft, wet. Layer, 0.7', brown fine to medium sandy organics, some silt, wet.		1		
8		S-4 2.0/1.6	☒	G	22.6			Olive fine sand, little silt, little organic (roots and peat), loose.		5		
10	WOM	S-5 2.0/1.6	☒					Some silt, trace organics.		7		
11	WOM											
12	6	S-6 2.0/1.0	☒					Trace silt, no organics, medium dense.		17		
13	14											
14	7	S-7 2.0/0.7	☒	G D	31.0			Trace coarse sand.		16		
15	7											
16	12											
17	27											
18	30											
19	32											
20	10	S-8 2.0/0.4	☒					Grayish brown fine to coarse sand, trace silt, medium dense, wet.		13		
21	15											
22	25											
23	26											
24	27											
25	25	S-9 2.0/0.7	☒	G	15.3			Trace gravel.		27		
26	39											
27	31											
28	46											
29	50											
30	41	S-10 2.0/0.7	☒					Light brown fine to medium sand, some silt, little fractured rock and gravel, dense, wet.		33		
31	50											
32	61											
33	53											
34	67											
35	54	S-11 2.0/0.5	☒					Lense, 0.2', coarse sand.		86		
36	60											
37	78											
38	91											
39	121											
40												

U: 3" or 3½" thin wall tube S: split spoon R: rock C: 2" thin wall tube

PRELIMINARY GEOTECHNICAL INVESTIGATION
OF ENGINEERING PROPERTIES
NEW BEDFORD HARBOR SUPERFUND SITE
BRISTOL COUNTY, MASSACHUSETTS

E.C.JORDAN CO.
CONSULTING ENGINEERS

Engineering Log of: BL-108		Page 1/2
Project No. 4959-19	Date Drilled 1/25-1/26/88	Sheet A-34

DEPTH (FT.)	CASING BLOWS/FT.	SAMPLE NO. PENETRATION/RECOVERY	SAMPLE	LAB TEST	WATER CONTENT (%)	SHEAR STRENGTH, Su PEAK/RESIDUAL (psf)	ROD PROBE (BLOWS/FT.)	SOIL DESCRIPTION	SOIL CLASS	STANDARD PENETRATION RESISTANCE BLOWS/FT 0 10 20 30 40 50 60	PIEZOMETER DATA	ELEV. (FT.)
40	x	S-12 2.0 0.8	☒					Olive fine to medium silty sand, trace gravel, trace coarse sand, trace clay, dense, wet. #No penetration after 100 blows.		34		
41	x											
42	x											
43	x											
44		S-13						44.6		(100)#		
45		0.6 0.0						*REFUSAL SURFACE ENCOUNTERED AT DEPTH OF 44.6 FEET				
50												
55												
60												
65												
70												
75												
80												

*Refusal of drilling tools and sampling equipment with methods used. Refusal surface is assumed to represent bedrock.

x Casing blows/ft. not recorded.

U: 3" or 3½" thin wall tube S: split spoon R: rock C: 2" thin wall tube

PRELIMINARY GEOTECHNICAL INVESTIGATION
OF ENGINEERING PROPERTIES
NEW BEDFORD HARBOR SUPERFUND SITE
BRISTOL COUNTY, MASSACHUSETTS

E.C.JORDAN CO.
CONSULTING ENGINEERS

Engineering Log of: BL-108 Page 2/2

Project No. 4959-19

Date Drilled 1/25-1/26/88

Sheet A-35

DEPTH (FT.)	CASING BLOWS/FT.	SAMPLE NO. PENETRATION/RECOVERY	SAMPLE	LAB TEST	WATER CONTENT (%)	SHEAR STRENGTH, Su PEAK/RESIDUAL (psf) ROD PROBE (BLOWS/FT.)	SOIL DESCRIPTION	SOIL CLASS	STANDARD PENETRATION RESISTANCE BLOWS/FT 0 10 20 30 40 50 60	PIEZOMETER DATA	ELEV. (FT.)
40						38	*Probed from 0.0' to 52.9' with BW drill rods and probe tip. Recorded blow counts per foot - 300 lb. hammer dropped 16".				
41						25					
42						26					
43						26					
44						51					
45						30					
						21					
						33					
						41					
						39					
50						29					
						31					
						56 + 80 +	No penetration.				
						52.9	*REFUSAL SURFACE ENCOUNTERED AT DEPTH OF 52.9 FEET				
55							*Refusal of drilling tools and sampling equipment with methods used. Refusal surface is assumed to represent bedrock.				
60											
65											
70											
75											
80											

U: 3" or 3½" thin wall tube S: split spoon R: rock C: 2" thin wall tube

**PRELIMINARY GEOTECHNICAL INVESTIGATION
OF ENGINEERING PROPERTIES
NEW BEDFORD HARBOR SUPERFUND SITE
BRISTOL COUNTY, MASSACHUSETTS**

E.C.JORDAN CO.
CONSULTING ENGINEERS

Engineering Log of: PL-101		Page 2/2
Project No. 4959-19	Date Drilled 1/28/88	Sheet A-37

DEPTH (FT.)	CASING BLOWS/FT.	SAMPLE NO. PENETRATION/RECOVERY	SAMPLE	LAB TEST	WATER CONTENT (%)	SHEAR STRENGTH, Su PEAK/RESIDUAL (psf) ROD PROBE (BLOWS/FT.)	SOIL DESCRIPTION	SOIL CLASS	STANDARD PENETRATION RESISTANCE BLOWS/FT 0 10 20 30 40 50 60	PIEZOMETER DATA	ELEV. (FT.)
40						38	Probed from 0.0' to 52.9' with BW drill rods and probe tip. Recorded blow counts per foot - 300 lb. hammer dropped 16".				
41						25					
42						26					
43						26					
44						51					
45						30					
						21					
						33					
						41					
						39					
50						29					
						31					
						56 + 80 +	No penetration.				
						52.9	*REFUSAL SURFACE ENCOUNTERED AT DEPTH OF 52.9 FEET				
55											
							*Refusal of drilling tools and sampling equipment with methods used. Refusal surface is assumed to rrepresent bedrock.				
60											
65											
70											
75											
80											

U: 3" or $3\frac{1}{2}$" thin wall tube S: split spoon R: rock C: 2" thin wall tube

PRELIMINARY GEOTECHNICAL INVESTIGATION OF ENGINEERING PROPERTIES NEW BEDFORD HARBOR SUPERFUND SITE BRISTOL COUNTY, MASSACHUSETTS

E.C.JORDAN CO.
CONSULTING ENGINEERS

Engineering Log of: PL-101 Page 2/2

Project No. 4959-19

Date Drilled 1/28/88

Sheet A-37

GZA DRILLING INC.
246 BAILEY ST., CANTON, MA. 02021
(A DIVISION OF GOLDBERG-ZOINO & ASSOC., INC.)

PROJECT
Proposed North Terminal
New Bedford Harbor, MA.

REPORT OF BORING No. 1
SHEET 1 OF 1
FILE No. 9213/C-5436
CHKD. BY DH

FOREMAN: C. Lenling
CLASSIFIED BY: R. Kubiak
INSPECTOR: None

BORING LOCATION As on Plan
GROUND SURFACE ELEVATION 82.2 DATUM BM #1
DATE START 3/4/85 DATE END 3/4/85

SAMPLER: UNLESS OTHERWISE NOTED, SAMPLER CONSISTS OF A 2" SPLIT SPOON DRIVEN USING A 140 lb. HAMMER FALLING 30 in.
CASING: UNLESS OTHERWISE NOTED, CASING DRIVEN USING 300 lb. HAMMER FALLING 24 in.
CASING SIZE: BW-2½" I.D. OTHER:

GROUNDWATER READINGS

DATE	TIME	WATER AT	CASING AT	STABILIZATION TIME

DEPTH (ft)	CASING (bl/ft)	SAMPLE No.	SAMPLE PEN. (in)/REC.	SAMPLE DEPTH (ft)	SAMPLE BLOWS/6"	SAMPLE DESCRIPTION Burmister CLASSIFICATION	REMARKS	DEPTH OF STRATUM CHANGE
0		1	24/13	0-2	Push	Very soft, black, Organic SILT, trace Shells		ORGANIC SILT
5		2	24/15	5-7	1-1-1-1	Very soft, dark grey, Organic SILT		5.0
10		3	24/18	10-12	1-1-1-2	Very soft, dark grey, Organic SILT, little Shells		
		4	24/10	12.5-14.5	8-6-6-7	Medium dense, dark grey, Organic SILT, some Gravel		12.5 ORGANIC SILT with Gravel
15								15.0
		5	24/12	19-21	18-15-12-14	Medium dense, brown, fine to coarse SAND, some Gravel, trace Silt		
20								SAND and GRAVEL
25		6	6/6	25-25.5	100	Very dense, brown, fine to coarse SAND, and Gravel, trace Silt	1	Refusal at 25.5'
30								

GRANULAR SOILS BLOWS/FT.	GRANULAR SOILS DENSITY	COHESIVE SOILS BLOWS/FT.	COHESIVE SOILS DENSITY
0-4	V. LOOSE	<2	V. SOFT
4-10	LOOSE	2-4	SOFT
10-30	M. DENSE	4-8	M. STIFF
30-50	DENSE	8-15	STIFF
>50	V. DENSE	15-30	V. STIFF
		>30	HARD

REMARKS:
1) Refusal defined as 100 blows with 300# hammer on open end aw rod for zero penetration
2) All elevations measured from reference benchmark on dock, assumed elevation 100.00

NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES, TRANSITIONS MAY BE GRADUAL.
2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORING LOGS. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE.

BORING No. 1

GZA DRILLING INC.
246 BAILEY ST., CANTON, MA. 02021
(A DIVISION OF GOLDBERG-ZOINO & ASSOC., INC.)

PROJECT
Proposed North Terminal
New Bedford Harbor, MA.

REPORT OF BORING No. 2
SHEET 1 OF 2
FILE No. 9213/C-5436
CHKD. BY DH

FOREMAN: C. Lenling
CLASSIFIED BY: R. Kubiak
INSPECTOR: None
BORING LOCATION As on Plan
GROUND SURFACE ELEVATION 83.1 DATUM BM #1
DATE START 3/1/85 DATE END 3/1/85

SAMPLER: UNLESS OTHERWISE NOTED, SAMPLER CONSISTS OF A 2" SPLIT SPOON DRIVEN USING A 140 lb. HAMMER FALLING 30 in.
CASING: UNLESS OTHERWISE NOTED, CASING DRIVEN USING 300 lb. HAMMER FALLING 24 in.
CASING SIZE: BW-2½" I.D. OTHER:

GROUNDWATER READINGS

DATE	TIME	WATER AT	CASING AT	STABILIZATION TIME

DEPTH (ft)	CASING (bl/ft)	SAMPLE No.	SAMPLE PEN. (in) / REC.	SAMPLE DEPTH (ft)	SAMPLE BLOWS/6"	SAMPLE DESCRIPTION Burmister CLASSIFICATION	REMARKS	DEPTH OF STRATUM CHANGE
0		1	24/24	0-2	Push	Very soft, dark grey, Organic SILT, trace Shells		
5		2	24/24	5-7	Push	Very soft, dark grey, Organic SILT, trace Shells		ORGANIC SILT
10		3	24/18	10-12	1-1-1-1	Very soft, dark grey, Organic SILT, trace Shells		
15		4	24/20	15-17	1-1-1-2	Very soft, dark grey, Organic SILT		
								17.0
20		5	24/18	20-22	4-4-5-5	Loose, grey, fine SAND, little Silt		Fine, Silty SAND
25		6	24/20	25-27	4-6-6-5	Medium dense, grey, fine SAND, trace Silt		
30		7	24/16	30-32	4-6-6-6	Medium dense, grey, fine to medium SAND, trace Silt		30.0 Fine to medium SAND

GRANULAR SOILS BLOWS/FT.	GRANULAR SOILS DENSITY	COHESIVE SOILS BLOWS/FT.	COHESIVE SOILS DENSITY
0-4	V. LOOSE	< 2	V. SOFT
4-10	LOOSE	2-4	SOFT
10-30	M. DENSE	4-8	M. STIFF
30-50	DENSE	8-15	STIFF
>50	V. DENSE	15-30	V. STIFF
		>30	HARD

REMARKS:

NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES, TRANSITIONS MAY BE GRADUAL.
2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORING LOGS. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE.

BORING No. 2

GZA DRILLING INC.
246 BAILEY ST., CANTON, MA. 02021
(A DIVISION OF GOLDBERG·ZOINO & ASSOC., INC.)

PROJECT
Proposed North Terminal
New Bedford Harbor, MA.

REPORT OF BORING No. 2
SHEET 2 OF 2
FILE No. 9213/C-5436
CHKD. BY DH

DEPTH (ft.)	CASING (bl/ft)	SAMPLE No.	SAMPLE PEN. (In)/REC.	SAMPLE DEPTH (ft)	SAMPLE BLOWS/6"	SAMPLE DESCRIPTION Burmister CLASSIFICATION	REMARKS	DEPTH OF STRATUM CHANGE
35			24/10	35-37	5-7-7-8	Medium dense, grey, fine to medium SAND, trace Silt		Fine to Medium SAND
40			24/16	40-42	8-9-9-12	Medium dense, grey, fine to medium SAND, trace Silt		
								43.0 Gravelly SAND
45			24/12	45-47	16-21-25-32	Dense, brown, fine to coarse SAND, some Gravel, little Silt		
							1	Refusal at 47.8'
50								

REMARKS: 1) Refusal defined as 100 blows with 300# hammer on open end aw rod for zero penetration

BORING No. 2

GZA DRILLING INC.
246 BAILEY ST., CANTON, MA. 02021
(A DIVISION OF GOLDBERG-ZOINO & ASSOC., INC.)

PROJECT
Proposed North Terminal
New Bedford Harbor, MA.

REPORT OF BORING No. 3
SHEET 1 **OF** 1
FILE No. 9213/C-5436
CHKD. BY DH

FOREMAN: C. Lenling
CLASSIFIED BY: R. Kubiak
INSPECTOR: None

BORING LOCATION As on Plan
GROUND SURFACE ELEVATION 81 **DATUM** BM #1
DATE START 3/5/85 **DATE END** 3/5/85

SAMPLER: UNLESS OTHERWISE NOTED, SAMPLER CONSISTS OF A 2" SPLIT SPOON DRIVEN USING A 140 lb. HAMMER FALLING 30 in.
CASING: UNLESS OTHERWISE NOTED, CASING DRIVEN USING 300 lb. HAMMER FALLING 24 in.
CASING SIZE: BW-2½" I.D. **OTHER:**

GROUNDWATER READINGS				
DATE	TIME	WATER AT	CASING AT	STABILIZATION TIME

DEPTH (ft.)	CASING (bl/ft)	SAMPLE No.	PEN. (in)/REC.	DEPTH (ft.)	BLOWS/6"	SAMPLE DESCRIPTION Burmister CLASSIFICATION	REMARKS	DEPTH OF STRATUM CHANGE
0		1	24/14	0-2	Push	Very soft, black, Organic SILT		
								ORGANIC SILT
5		2	24/18	5-7	1-1-1-1	Very soft, black, Organic SILT		
								7.8
10		3	24/10	9-11	4-6-6-8	Medium dense, brown, fine SAND, trace Silt		Fine SAND
								13.0
15		4	24/15	15-17	7-9-7-9	Medium dense, brown, fine to coarse SAND, some Gravel, trace Silt		Gravelly SAND
20		5	24/12	20-22	10-10-11-13	Medium dense, brown, fine to coarse SAND, some Gravel, trace Silt		
25		6	24/14	25-27	8-11-11-12	Medium dense, brown, fine to coarse SAND, some Gravel, trace Silt		25.0
30		7	24/18	30-32	15-14-15-16	Medium dense, brown, fine to coarse SAND, and Gravel, trace Silt		
35		8	5/4	35-35.4	125/5"	Very dense, brown, fine to coarse SAND, and Gravel, trace Silt	1	Refusal at 35.5'

GRANULAR SOILS		COHESIVE SOILS	
BLOWS/FT.	DENSITY	BLOWS/FT.	DENSITY
0-4	V. LOOSE	<2	V. SOFT
4-10	LOOSE	2-4	SOFT
10-30	M. DENSE	4-8	M. STIFF
30-50	DENSE	8-15	STIFF
>50	V. DENSE	15-30	V. STIFF
		>30	HARD

REMARKS: 1) Refusal defined as 100 blows with 300# hammer on open end aw rod for zero penetration

NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES, TRANSITIONS MAY BE GRADUAL.
2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORING LOGS. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE.

BORING No. 3

GZA DRILLING INC.
246 BAILEY ST., CANTON, MA. 02021
(A DIVISION OF GOLDBERG-ZOINO & ASSOC., INC.)

PROJECT
Proposed North Terminal
New Bedford Harbor, MA.

REPORT OF BORING No. 4
SHEET 1 OF 2
FILE No. 9213/C-5436
CHKD. BY DH

FOREMAN: C. Lenling
CLASSIFIED BY: R. Kubiak
INSPECTOR: None

BORING LOCATION As on Plan
GROUND SURFACE ELEVATION 85.0 DATUM BM #1
DATE START 2/28/85 DATE END 2/28/85

SAMPLER: UNLESS OTHERWISE NOTED, SAMPLER CONSISTS OF A 2" SPLIT SPOON DRIVEN USING A 140 lb. HAMMER FALLING 30 in.
CASING: UNLESS OTHERWISE NOTED, CASING DRIVEN USING 300 lb. HAMMER FALLING 24 in.
CASING SIZE: BW- 2½" I.D. OTHER:

GROUNDWATER READINGS

DATE	TIME	WATER AT	CASING AT	STABILIZATION TIME

DEPTH (ft)	CASING (bl/ft)	SAMPLE No.	PEN. (in)/REC.	DEPTH (ft)	BLOWS/6"	SAMPLE DESCRIPTION Burmister CLASSIFICATION	REMARKS	DEPTH OF STRATUM CHANGE
0		1	24/16	0-2	Push	Very soft, dark grey, Organic SILT		Organic SILT
5		2	24/15	5-7	1-2-2-3	Soft, dark grey, Organic SILT, little fine Sand		
								7.5
10		3	24/18	10-12	4-3-3-3	Loose, brown, Clayey SILT, some fine Sand		Clayey SILT
								12.0
15		4	24/20	15-17	5-7-10-10	Medium dense, brown, fine to medium SAND, trace Silt		
20		5	24/16	20-22	9-11-11-13	Medium dense, brown, fine to medium SAND, trace Silt		Fine to medium SAND
25		6	24/18	25-27	10-10-12-10	Medium dense, brown, fine to medium SAND, trace Silt		
								29.0
30		7	24/20	30-32	14-17-16-17	Dense, brown, fine to coarse SAND, some Gravel, trace Silt		Gravelly SAND

GRANULAR SOILS		COHESIVE SOILS	
BLOWS/FT.	DENSITY	BLOWS/FT.	DENSITY
0-4	V. LOOSE	<2	V. SOFT
4-10	LOOSE	2-4	SOFT
10-30	M. DENSE	4-8	M. STIFF
30-50	DENSE	8-15	STIFF
>50	V. DENSE	15-30	V. STIFF
		>30	HARD

REMARKS:

NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES, TRANSITIONS MAY BE GRADUAL.
2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORING LOGS. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE.

BORING No. 4

GZA DRILLING INC.
246 BAILEY ST., CANTON, MA. 02021
(A DIVISION OF GOLDBERG-ZOINO & ASSOC., INC.)

PROJECT
Proposed North Terminal
New Bedford Harbor, MA.

REPORT OF BORING No. 4
SHEET 2 OF 2
FILE No. 9213/C-5436
CHKD. BY DH

DEPTH (ft.)	CASING (bl/ft)	SAMPLE No.	PEN. (in)/REC.	DEPTH (ft)	BLOWS/6"	SAMPLE DESCRIPTION Burmister CLASSIFICATION	REMARKS	DEPTH OF STRATUM CHANGE
35		8	24/21	35-37	13-20-18-18	Dense, brown, fine to coarse SAND, some Gravel, trace Silt		SAND and GRAVEL
		9	24/19	38-40	24-30-28-30	Very dense, brown, GRAVEL, some fine to coarse Sand, trace Silt		
40								*Bottom of Boring at 40.0'*

REMARKS:

BORING No. 4

GZA DRILLING INC.
246 BAILEY ST., CANTON, MA. 02021
(A DIVISION OF GOLDBERG-ZOINO & ASSOC., INC.)

PROJECT
Proposed North Terminal
New Bedford, MA.

REPORT OF BORING No. 5
SHEET 1 OF 1
FILE No. 9213/C-5436
CHKD. BY DH

FOREMAN: C. Lenling
CLASSIFIED BY: R. Kubiak
INSPECTOR: None

BORING LOCATION As on Plan
GROUND SURFACE ELEVATION 87.8 DATUM BM #1
DATE START 3/6/85 DATE END 3/6/85

SAMPLER: UNLESS OTHERWISE NOTED, SAMPLER CONSISTS OF A 2" SPLIT SPOON DRIVEN USING A 140 lb. HAMMER FALLING 30 in.
CASING: UNLESS OTHERWISE NOTED, CASING DRIVEN USING 300 lb. HAMMER FALLING 24 in.
CASING SIZE: BW- 2½" I.D.
OTHER:

GROUNDWATER READINGS

DATE	TIME	WATER AT	CASING AT	STABILIZATION TIME

DEPTH (ft)	CASING (bl/ft)	SAMPLE No.	SAMPLE PEN. (in)/REC.	SAMPLE DEPTH (ft)	SAMPLE BLOWS/6"	SAMPLE DESCRIPTION Burmister CLASSIFICATION	REMARKS	DEPTH OF STRATUM CHANGE
0		1	24/10	0-2	Push	Very soft, black Organic SILT		
5		2	24/14	5-7	1-1-1-1	Very soft, dark brown, Organic SILT		Organic SILT
10		3	24/10	10-12	1-1-1-1	Very soft, dark brown, Organic SILT		
15		4	25/18	15-17	1-1-1-2	Very soft, dark brown, Organic SILT		
								17.0
20		5	24/20	20-22	4-7-7-9	Medium dense, dark grey, fine to coarse SAND, little Gravel, trace Silt		
25		6	24/16	25-27	8-9-8-9	Medium dense, grey, fine to coarse SAND, little Silt		Silty SAND
30		7	24/12	30-32	10-10-8-10	Medium dense, grey, fine to coarse SAND, some Gravel, little Silt		
								34.0
		8	24/15	35-37	14-13-13-12	Medium dense, grey, fine to coarse SAND, trace Silt		Fine to coarse SAND

GRANULAR SOILS BLOWS/FT.	GRANULAR SOILS DENSITY	COHESIVE SOILS BLOWS/FT.	COHESIVE SOILS DENSITY
0-4	V. LOOSE	< 2	V. SOFT
4-10	LOOSE	2-4	SOFT
10-30	M. DENSE	4-8	M. STIFF
30-50	DENSE	8-15	STIFF
>50	V. DENSE	15-30	V. STIFF
		>30	HARD

REMARKS:

Bottom of Boring at 37.0'

NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES, TRANSITIONS MAY BE GRADUAL.
2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORING LOGS. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE.

BORING No. 5

APPENDIX B

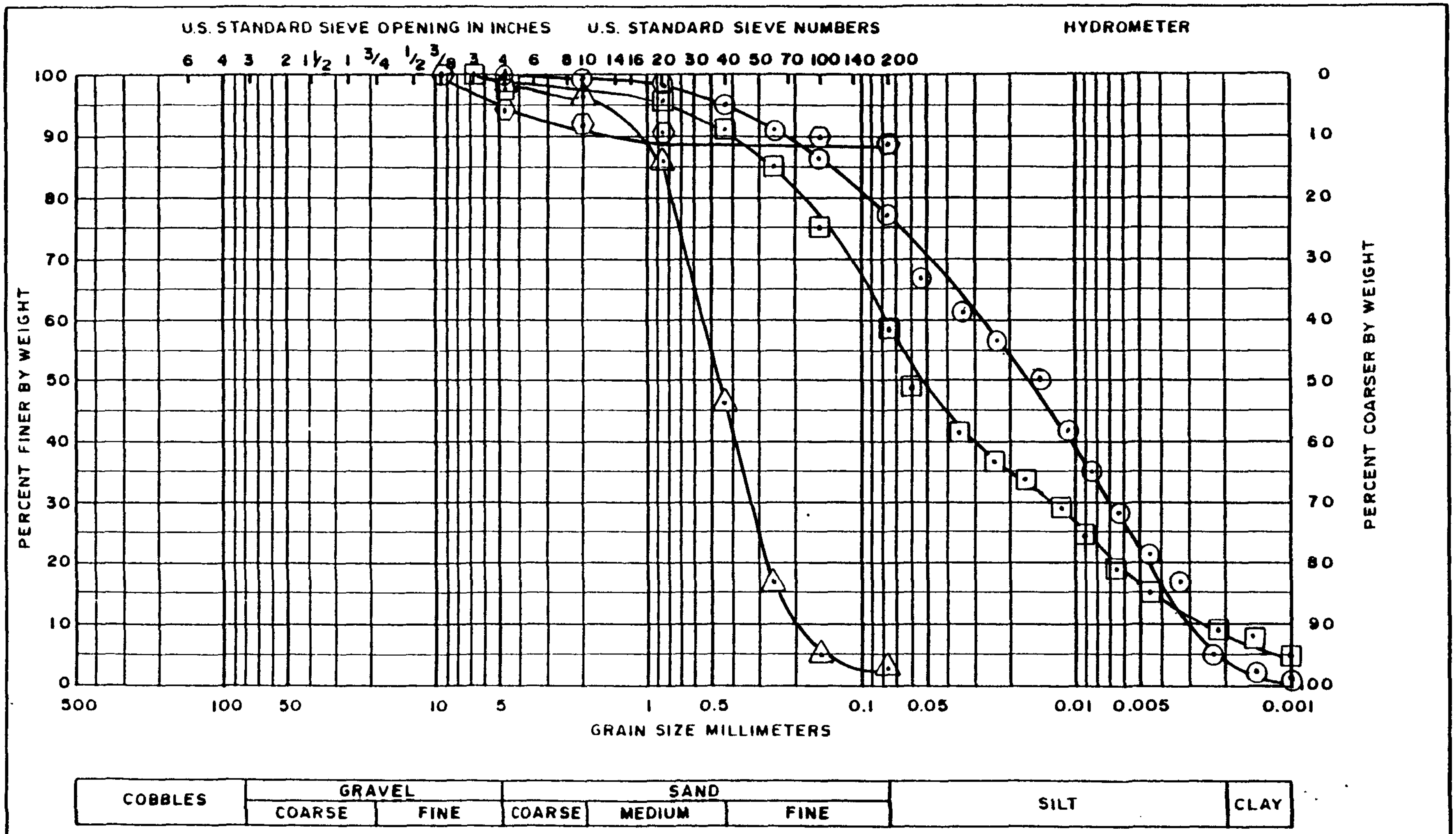
GRAIN SIZE ANALYSIS CURVES

APPENDIX B

TABLE OF CONTENTS

APPENDIX B

TABLE OF CONTENTS (Continued)



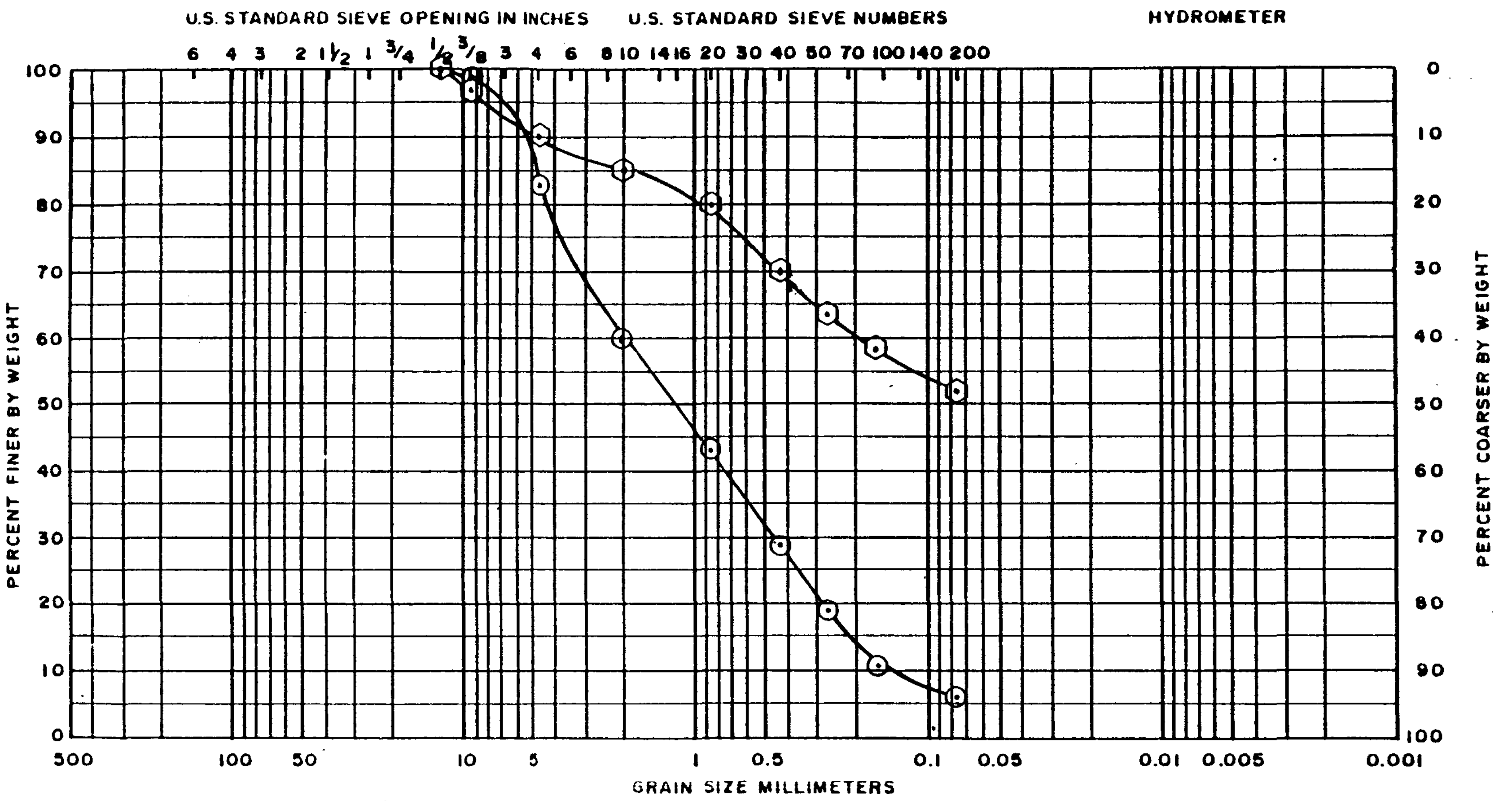
SAMPLE NO.	ELEV. OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
BW101 U1	⬡ 2-4'	Gray organic silt, trace sand & gravel	115.0			
BW101 U3	⊙ 6-8'	OH Gray organic silt, some sand	91.8	112.5	41.3	71.2
BW101 U4	⊡ 12-14'	OL Gray sandy organic silt, trace gravel	35.6	42.0	24.3	17.7
BW101 S6	△ 33-35'	SP Gray sand, trace silt & gravel	17.7			

JGA 003
1 APR 82

GRAIN SIZE DISTRIBUTION CURVES

PRELIMINARY GEOTECHNICAL INVESTIGATION
NEW BEDFORD HARBOR SUPERFUND SITE

TESTED BY KM/RS	CHECKED BY PD	PROJ NO. 4959-19
	DATE 4-7-88	B-2



COBBLES	GRAVEL		SAND			SILT	CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE		

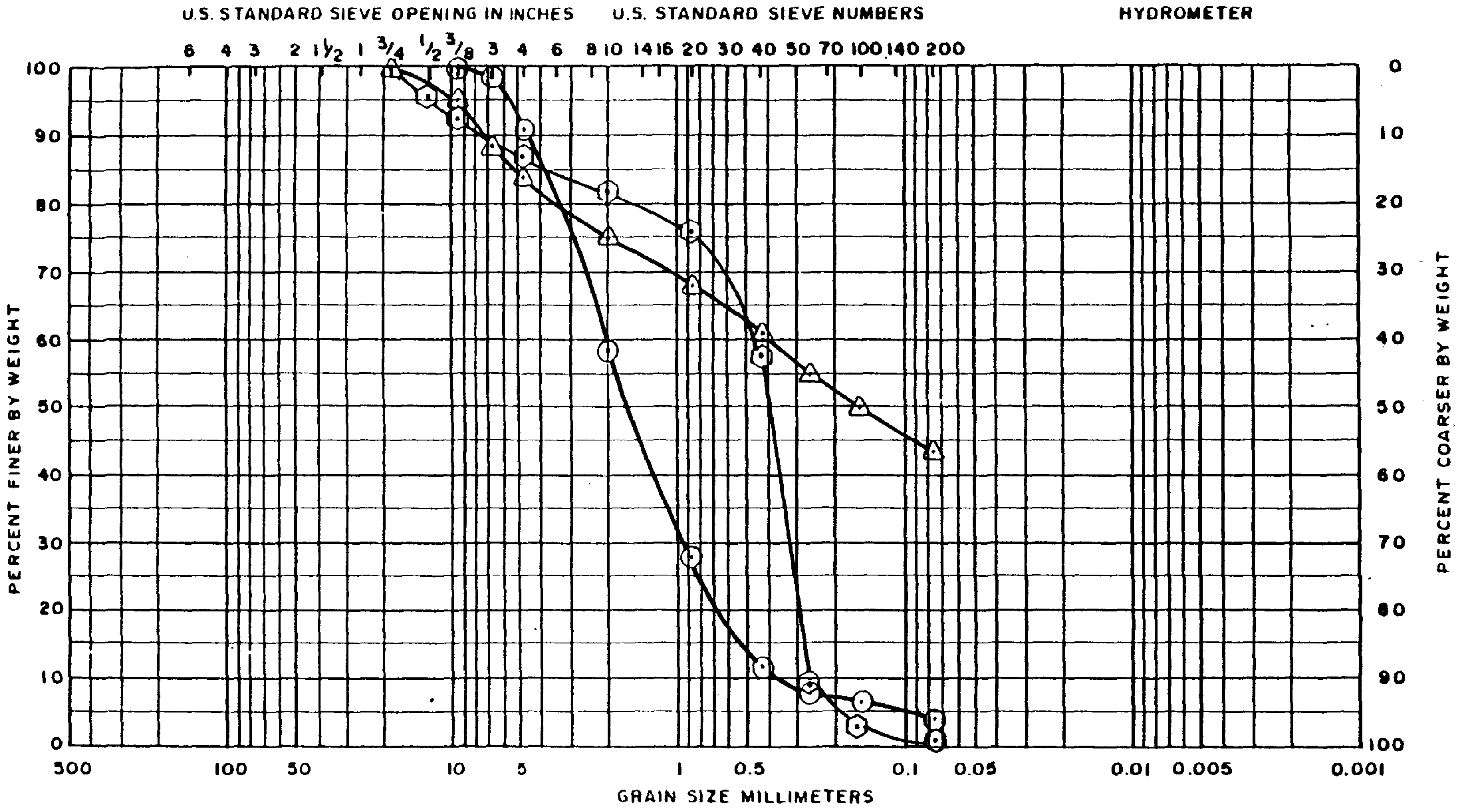
SAMPLE NO.	ELEV. OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
BW103 S6	⬡ 12-14'	Gray sandy silt, trace gravel	59.2			
BW103 S10	⊙ 23-25'	Brown sand, little gravel, trace silt SP-SM	10.5			

GRAIN SIZE DISTRIBUTION CURVES

PRELIMINARY GEOTECHNICAL INVESTIGATION
NEW BEDFORD HARBOR SUPERFUND SITE

TESTED BY	CHECKED BY	PROJ NO
KM	TS	4959-19
	DATE 4-1-88	B-3

JGA 003
1 APR 82



COBBLES	GRAVEL		SAND			SILT	CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE		

SAMPLE NO.	ELEV. OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
BW104 S7	△ 14-16'	SM Brown sandy silt, little gravel	18.1			
BW104 S9	⊙ 25-27'	SP Gray sand, trace gravel + silt	11.1			
BW104 S5	⬡ 10-12'	SP Brown sand, little gravel, trace silt	19.1			

GRAIN SIZE DISTRIBUTION CURVES

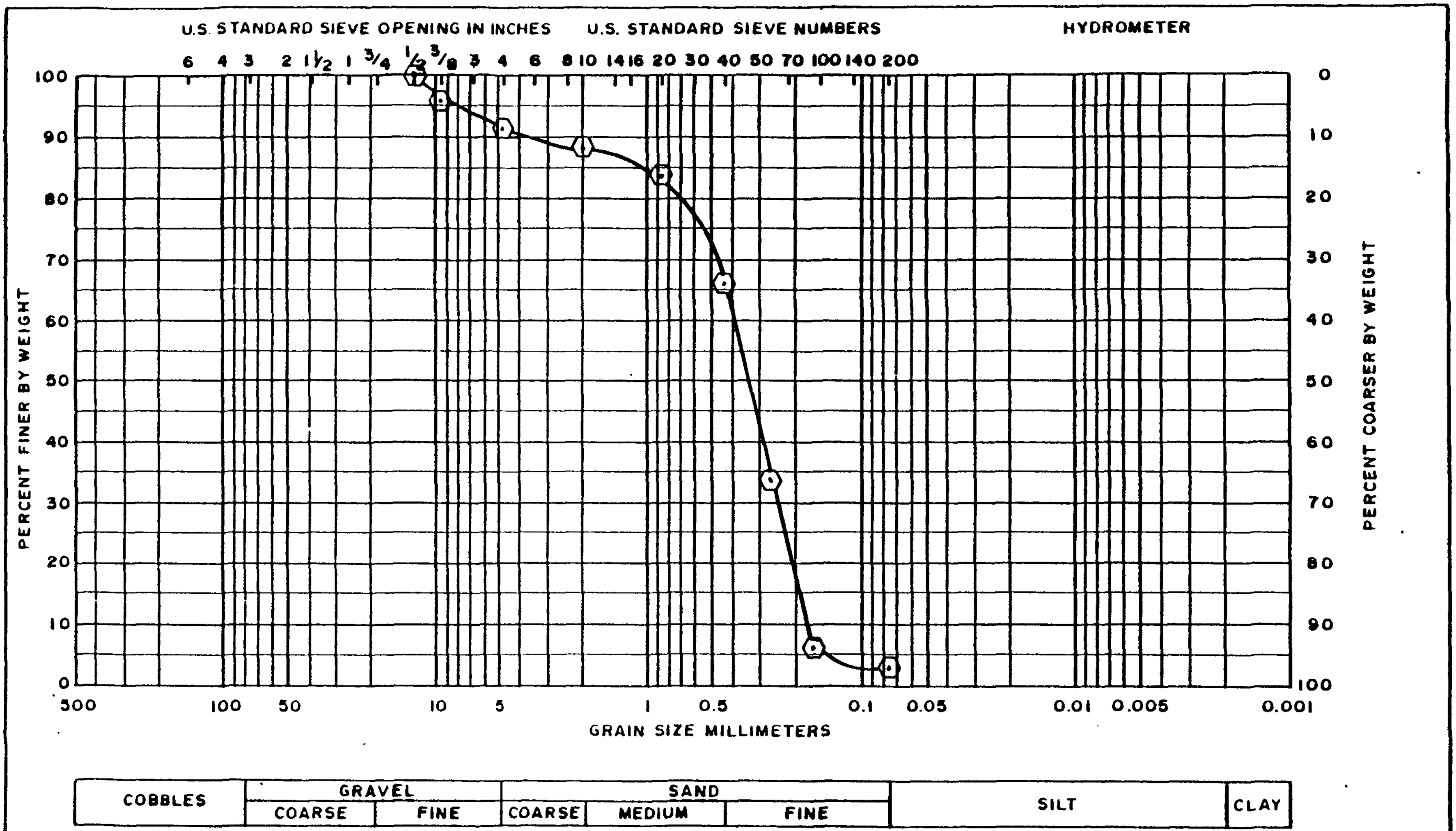
New Bedford Harbor

Geotechnical

TESTED BY	CHECKED BY	PROJ NO
KM		4959-19
	DATE 2-18-88	B-4

JGA 003
1 APR 82

JORDAN GORRILL ASSOCIATES
GEOTECHNICAL CONSULTANTS



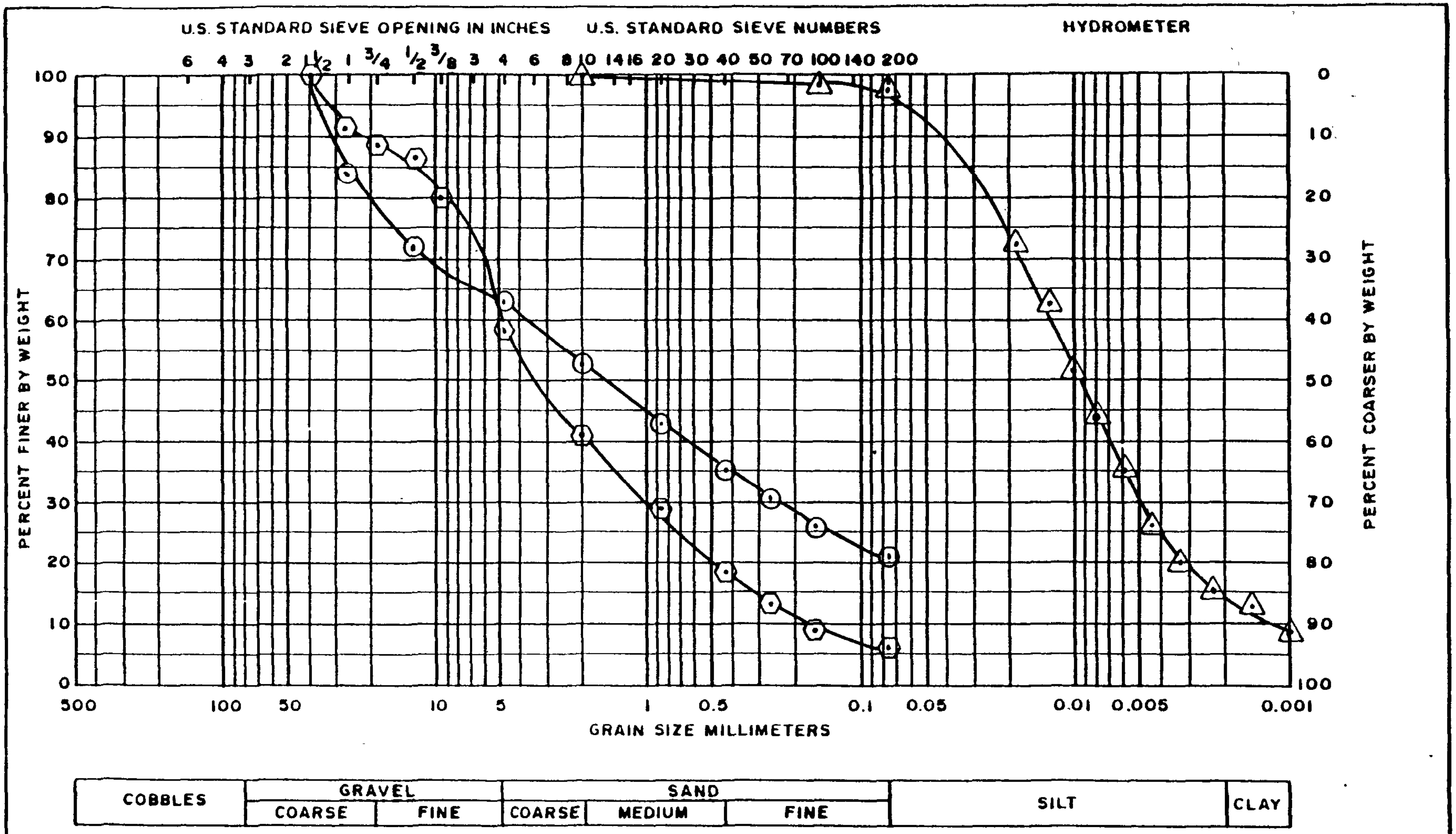
SAMPLE NO.	ELEV. OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
BW105 S2	⊙ 4.5-6.5'	SP Poorly graded sand, trace gravel & silt	12.1			

GRAIN SIZE DISTRIBUTION CURVES

PRELIMINARY GEOTECHNICAL INVESTIGATION
NEW BEDFORD HARBOR SUPERFUND SITE

TESTED BY TS	CHECKED BY PD	PROJ. NO. 4959-19
	DATE 4-1-88	B-5

JGA 003
1 APR 82



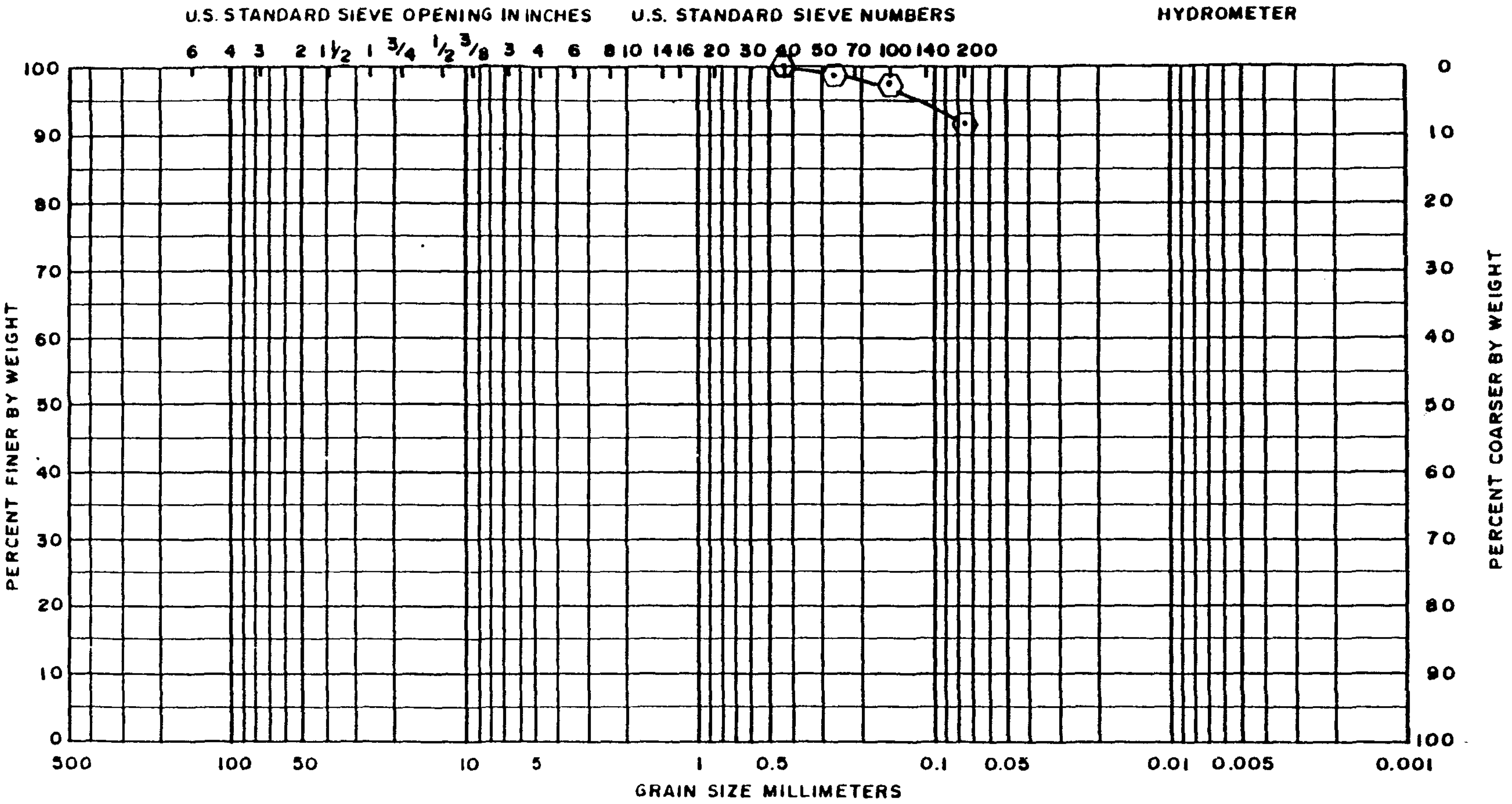
SAMPLE NO.	ELEV. OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
BW106 S6	⬡ 14-16'	SW-SM Gray gravelly sand, trace silt	11.4			
BW 106 S7	⊙ 19-21'	SM Gray gravelly sand, some silt	8.3			
BW106 U1	△ 6-8'	OH Gray silt, trace sand	82.2	102.2	47.5	54.7

GRAIN SIZE DISTRIBUTION CURVES

PRELIMINARY GEOTECHNICAL INVESTIGATION
NEW BEDFORD HARBOR SUPERFUND SITE

TESTED BY KM	CHECKED BY TS	PROJ NO 4959-19
	DATE 4-1-88	B-6

JGA 003
1 APR 82



COBBLES	GRAVEL		SAND			SILT	CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE		

SAMPLE NO.	ELEV. OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
BW 107 S6	⊙ 12-14'	Brown silt, trace fine sand	43.0			

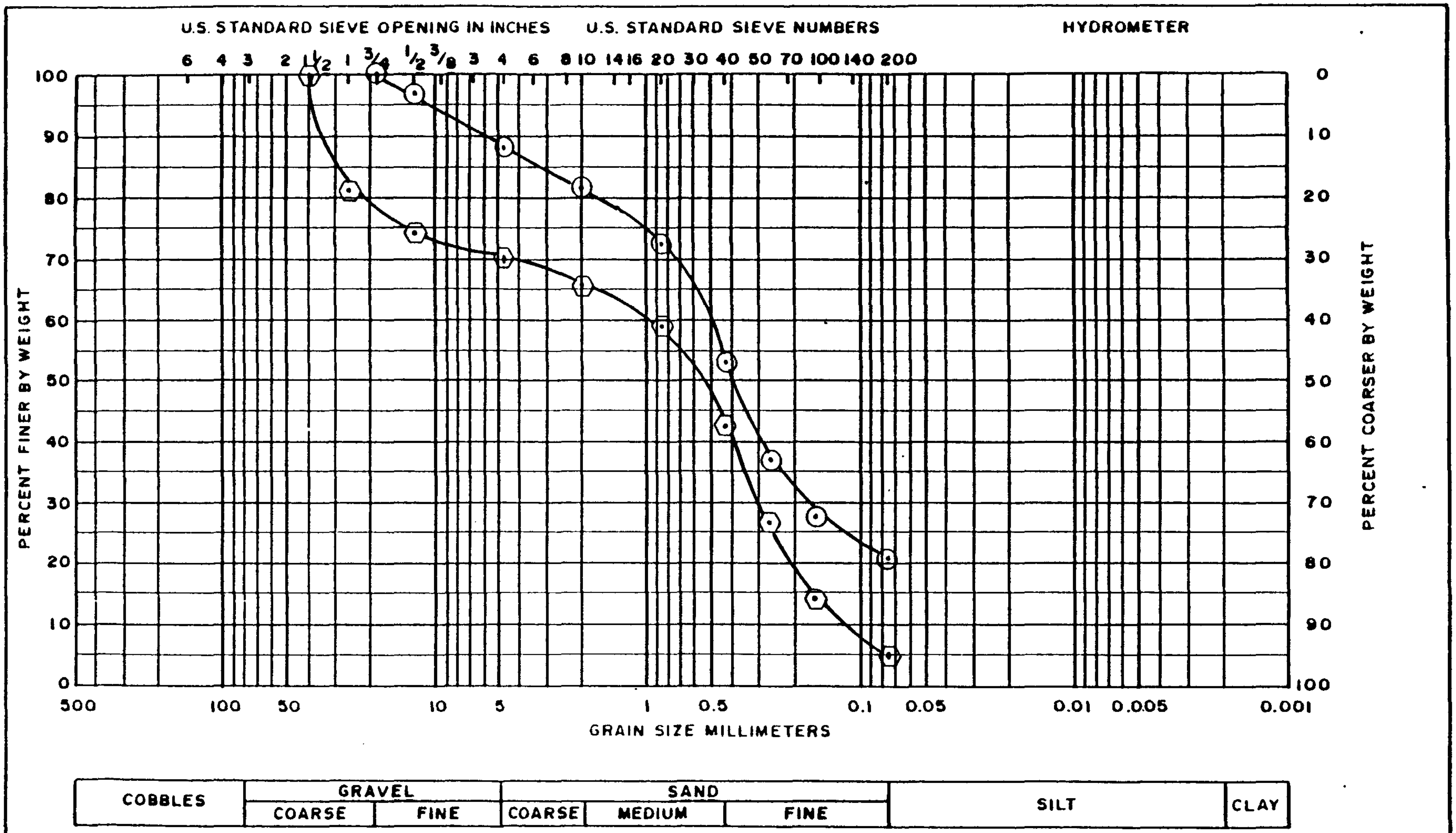
GRAIN SIZE DISTRIBUTION CURVES

PRELIMINARY GEOTECHNICAL INVESTIGATION

NEW BEDFORD HARBOR SUPERFUND SITE

TESTED BY	CHECKED BY	PROJ NO.
TS	PD	4959-19
	DATE 4-1-88	B-7

JGA 003
1 APR 82



SAMPLE NO.	ELEV. OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
BW 108A S1	⬡ 2-4'	SP Poorly graded sand, some gravel, trace silt	7.3			
BW 108 B S1	⊙ 4-6'	SM Brown sand, some silt, little gravel	10.2			

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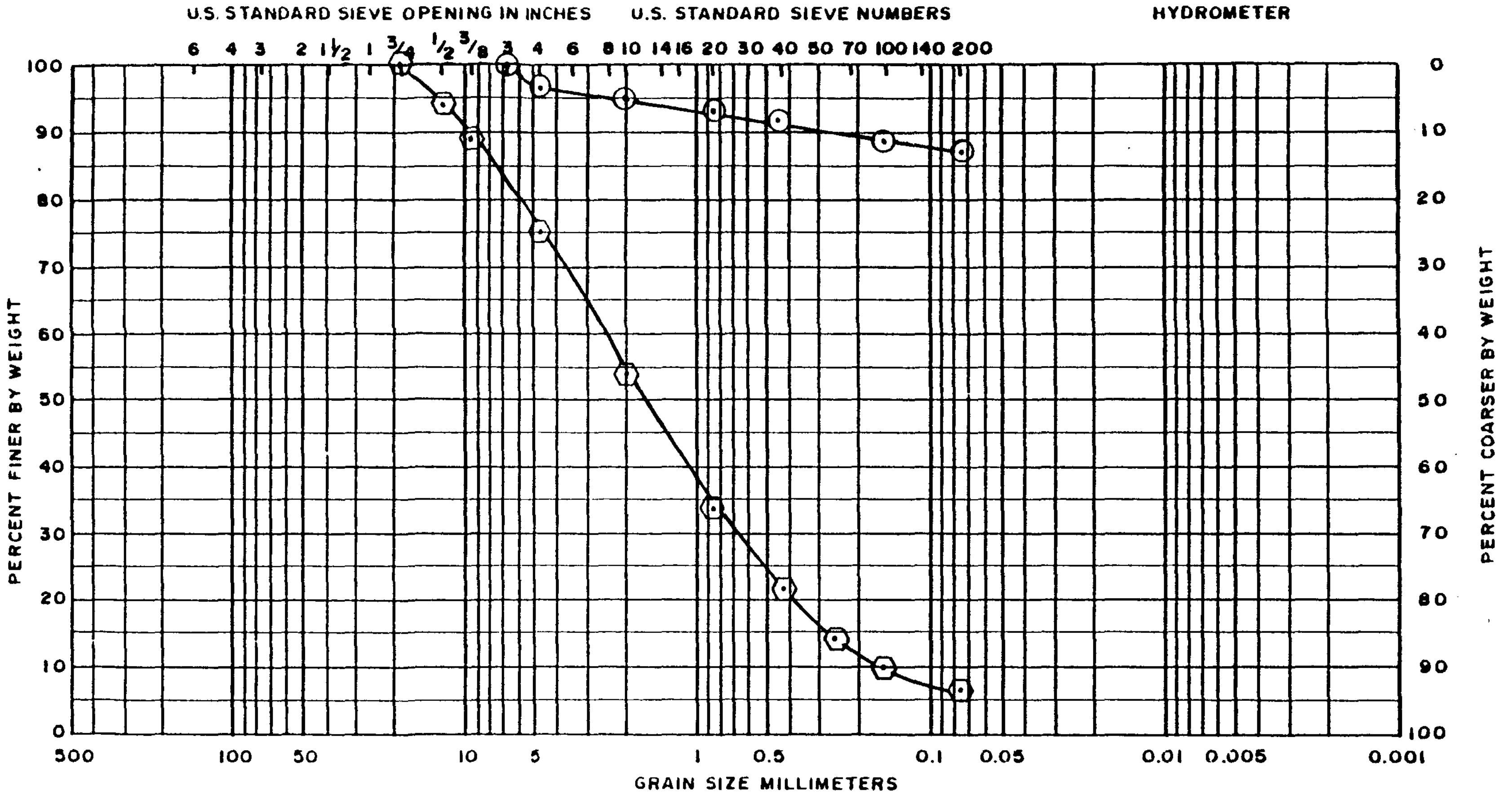
GRAIN SIZE DISTRIBUTION CURVES

PRELIMINARY GEOTECHNICAL INVESTIGATION
NEW BEDFORD HARBOR SUPERFUND SITE

TESTED BY	CHECKED BY	PROJ NO.
TS	PD	4959-19
	DATE 4-1-88	B-8



COBBLES	GRAVEL		SAND			SILT	CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE		

SAMPLE NO.	ELEV. OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
BW109 S2	⊙ 4-6'	Gray silt, trace sand & gravel	114.9			
BW 109 S7	⬡ 14-16'	SW-SM Gray sand, some gravel, trace silt	12.5			

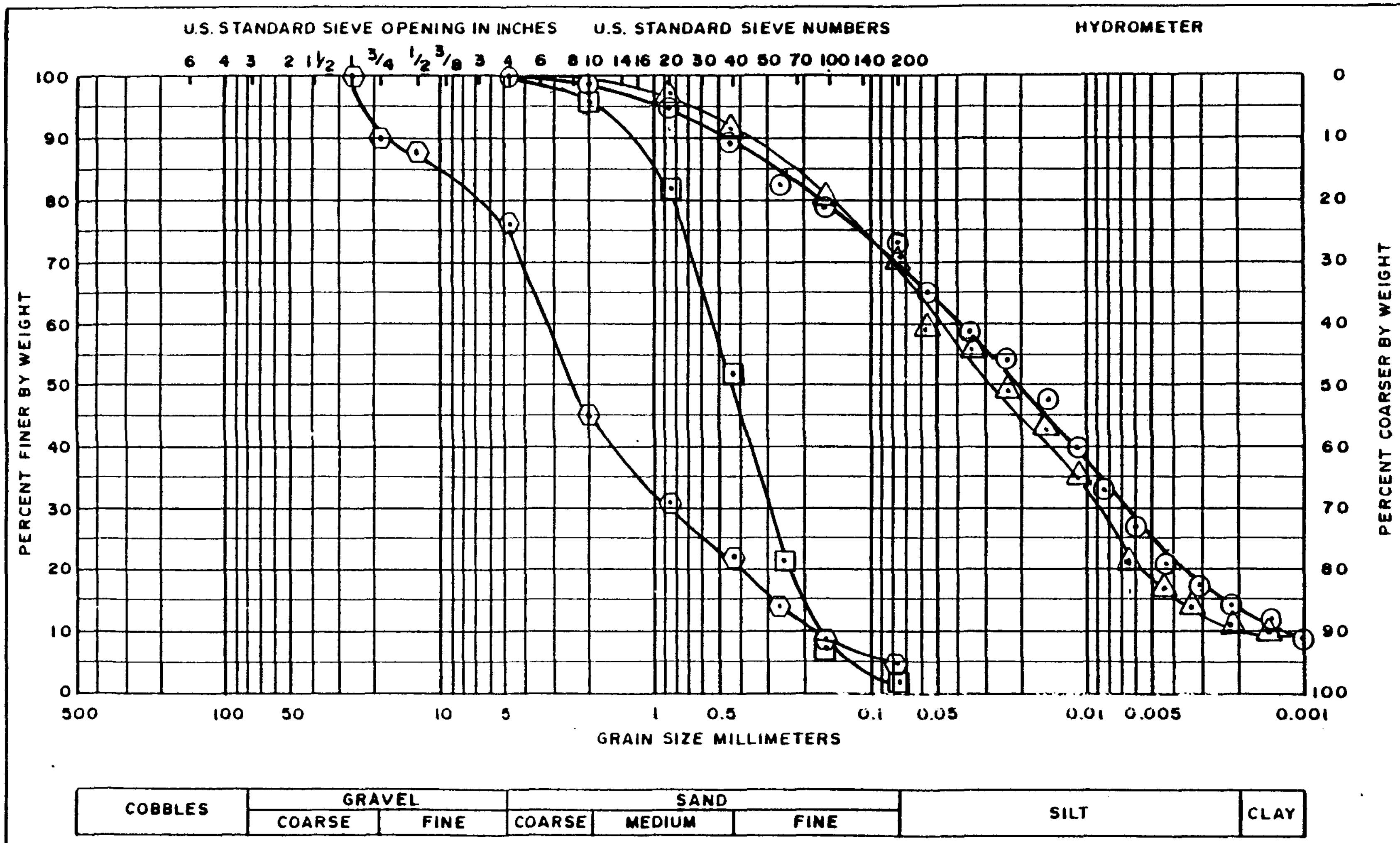
GRAIN SIZE DISTRIBUTION CURVES

PRELIMINARY GEOTECHNICAL INVESTIGATION

NEW BEDFORD HARBOR SUPERFUND SITE

TESTED BY	CHECKED BY	PROJ NO.
TS	PD	4959-19
	DATE 4-1-88	B-9

JGA 003
1 APR 82



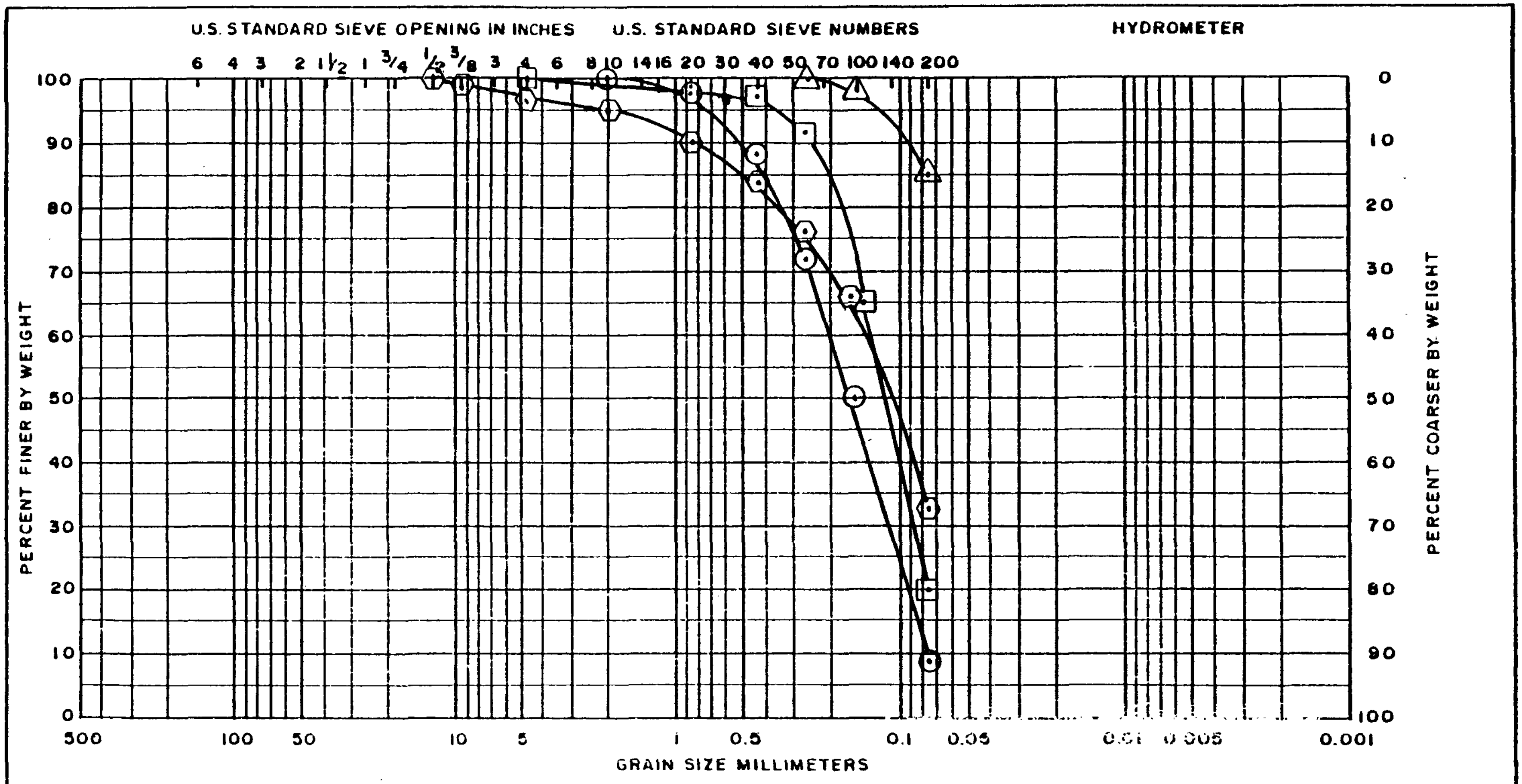
SAMPLE NO.	ELEV. OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
BW110 S9	⬡ 34-36'	SW-SM Gray sand, some gravel, trace silt	10.9			
BW 110 C1	⊙ 2-4'	OH Gray silt, some sand	88.5	85.2	34.4	50.8
BW 110 C2	△ 6-8'	OH Gray silt, some sand	59.7	57.0	26.4	30.6
BW 110 C4	⊡ 14-16'	SP Gray sand, trace silt	14.0			

GRAIN SIZE DISTRIBUTION CURVES

PRELIMINARY GEOTECHNICAL INVESTIGATION
NEW BEDFORD HARBOR SUPERFUND SITE

TESTED BY	CHECKED BY	PROJ NO.
TS	PD	4959-19
	DATE 4-1-88	B-10

JGA 003
1 APR 82



COBBLES	GRAVEL		SAND			SILT	CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE		

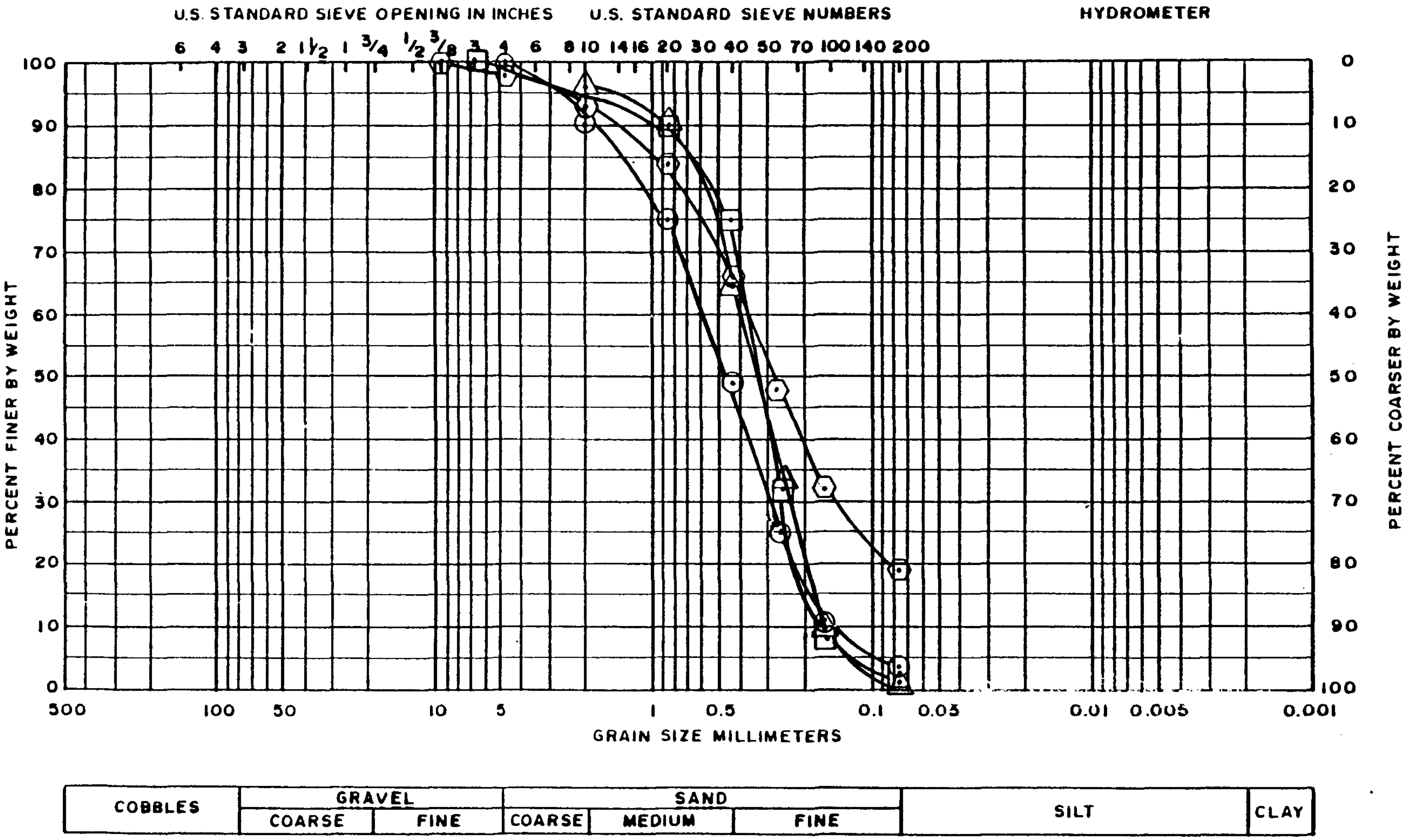
SAMPLE NO.	ELEV. OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
BW111 S1	⬡ 2-4'	SM Brown sand, some silt, trace gravel	18.0			
BW111 S3	⊙ 6-8'	SP-SM Brown sand, trace silt	33.7			
BW111 S11	⊡ 33-35'	SM Browish-gray sand, little silt	18.6			
BW111 S14	△ 48-50'	Gray silt, little sand	29.6			

GRAIN SIZE DISTRIBUTION CURVES

PRELIMINARY GEOTECHNICAL INVESTIGATION
NEW BEDFORD HARBOR SUPERFUND SITE

TESTED BY	CHECKED BY	PROJ NO
TS	PD.	4959-19
	DATE 4-1-88	B-11

JGA 003
1 APR 82



SAMPLE NO.	ELEV. OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
BW 112 S1	⬡ 2-4′	SM Gray sand, little silt, trace gravel	38.0			
BW 112 S3	⊙ 6-8′	SP Brown sand, trace silt	22.6			
BW 112 S8	⊡ 19-21′	SP Brown sand, trace gravel & silt	17.9			
BW 112 S10	△ 28-30′	SP Grayish brown sand, trace gravel & silt	17.6			

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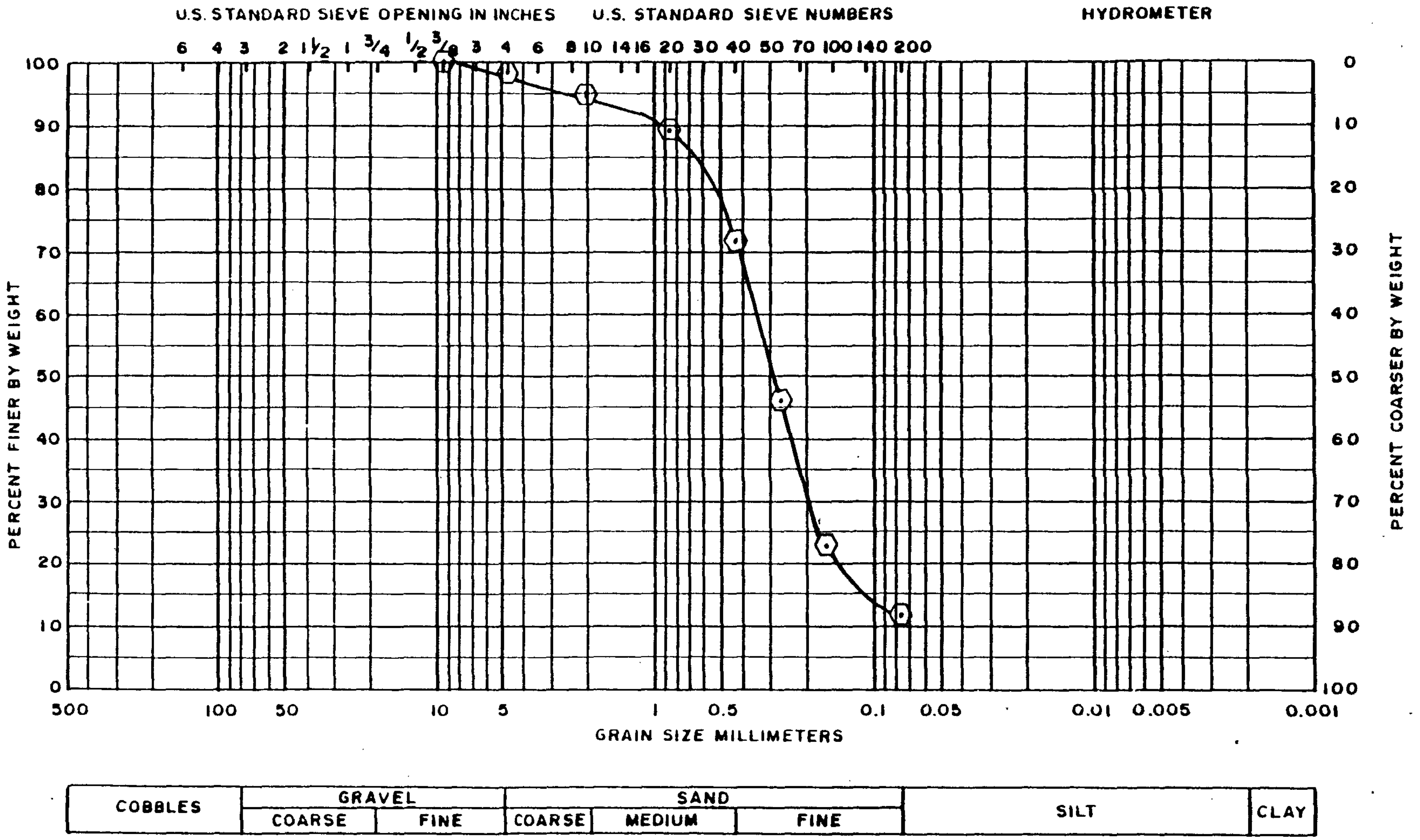
GRAIN SIZE DISTRIBUTION CURVES

PRELIMINARY GEOTECHNICAL INVESTIGATION
NEW BEDFORD HARBOR SUPERFUND SITE

TESTED BY	CHECKED BY	PROJ NO.
TS	PD	4959-19
	DATE 4-1-88	B-12



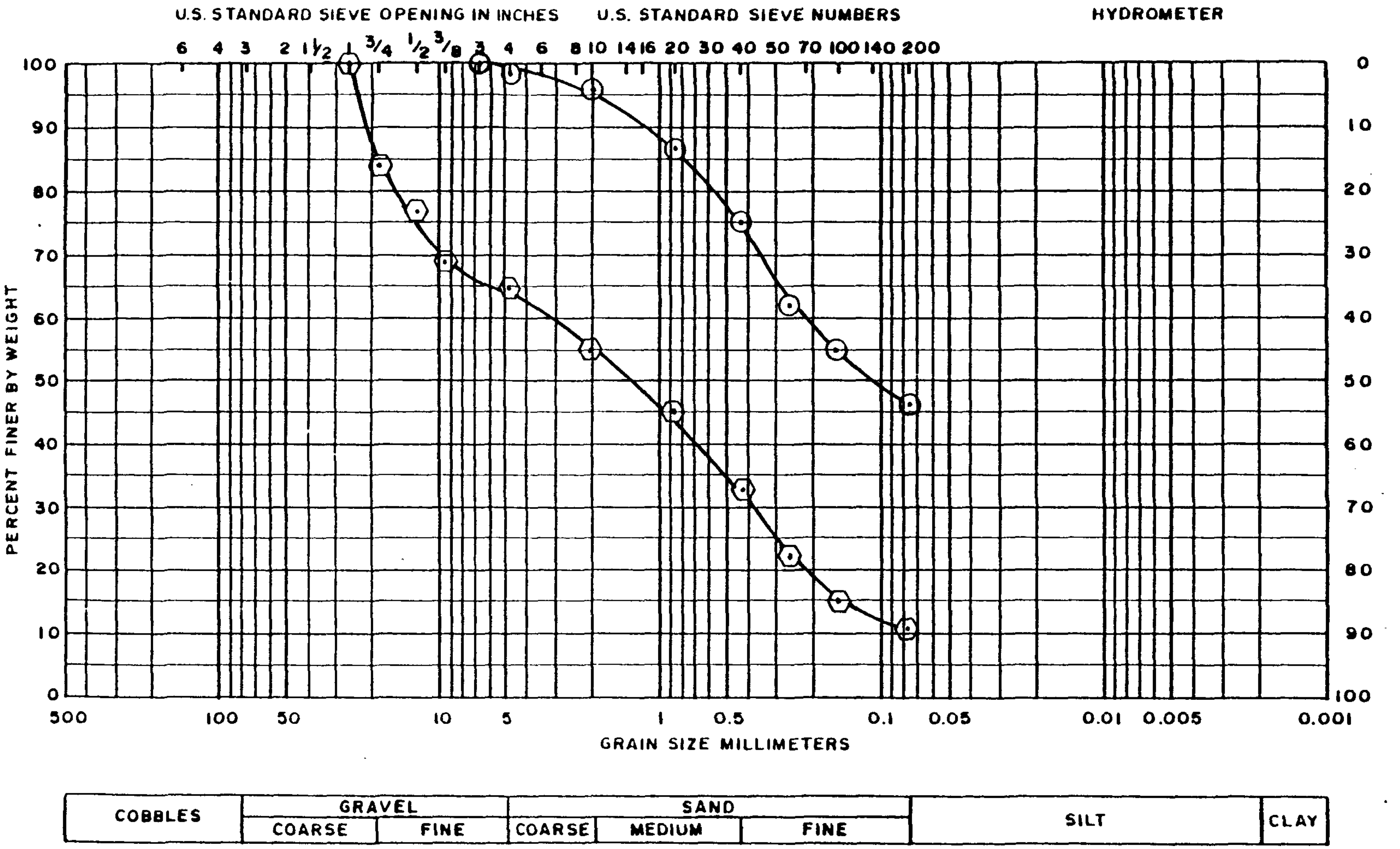
SAMPLE NO.	ELEV. OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
BL 101 S6	⊙ 12-14'	SP-SM Gray sand, little silt, trace gravel	6.1			

GRAIN SIZE DISTRIBUTION CURVES

PRELIMINARY GEOTECHNICAL INVESTIGATION
NEW BEDFORD HARBOR SUPERFUND SITE

TESTED BY	CHECKED BY	PROJ NO.
TS	PD	49-59-19
	DATE 1-1-88	B-13

JGA 003
1 APR 82



SAMPLE NO.	ELEV. OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
BL 103 S2	⬡ 4-6'	SP-SM Gray gravelly sand, little silt	11.0			
BL 103 S7	⊙ 14-16'	SM Gray silty sand, trace gravel	50.9			

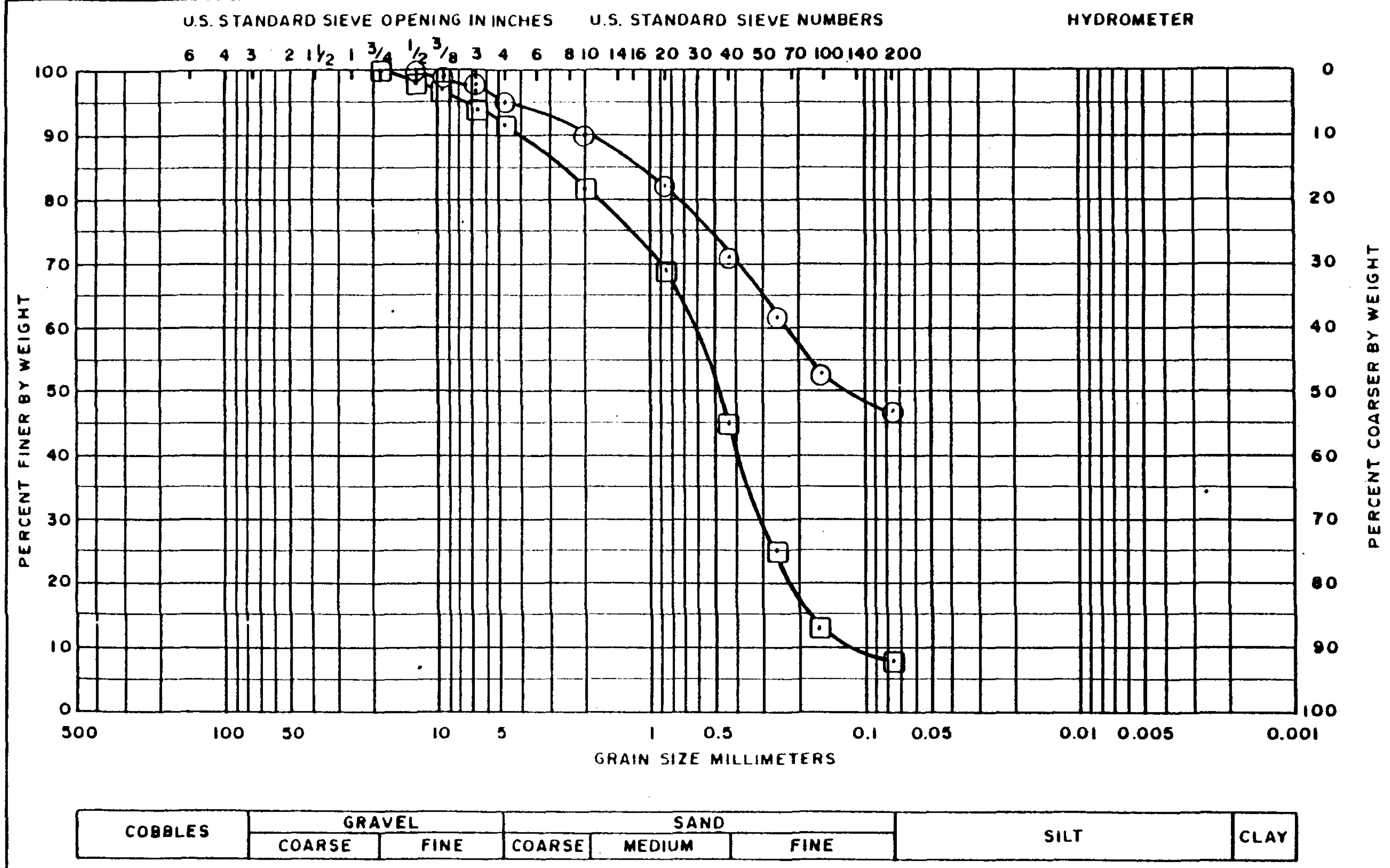
GRAIN SIZE DISTRIBUTION CURVES

PRELIMINARY GEOTECHNICAL INVESTIGATION

NEW BEDFORD HARBOR SUPERFUND SITE

TESTED BY	CHECKED BY	PROJ NO
TS	PD	4959-19
	DATE 4-1-88	B-14

JGA 003
1 APR 82



SAMPLE NO.	ELEV. OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
BL104 S3	⊙ 6-8'	SM Brown silty sand, trace gravel	22.3			
BL104 S8	⊡ 20-22'	SP-SM Gray & brown sand, trace gravel & sand	14.1			

GRAIN SIZE DISTRIBUTION CURVES

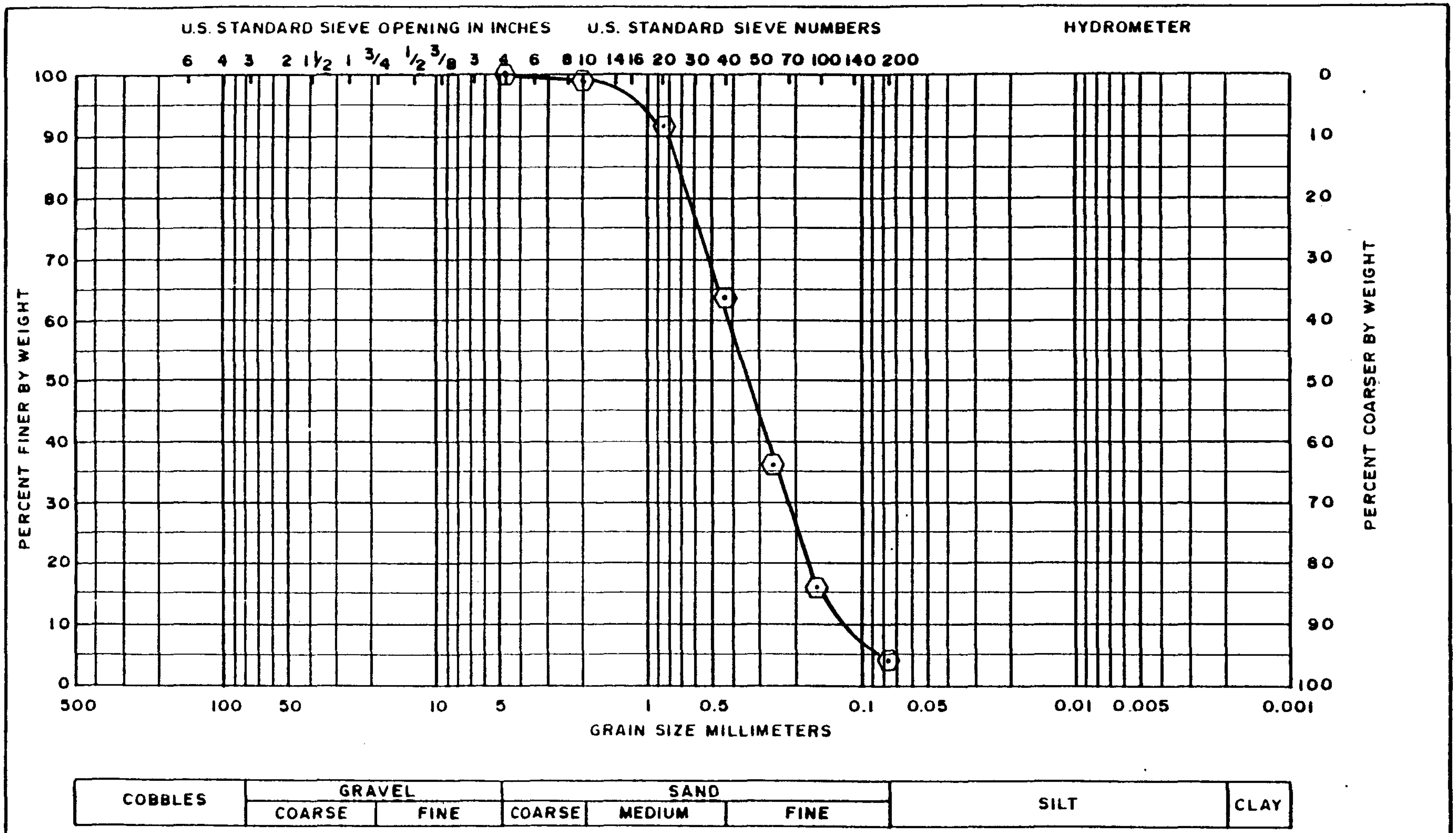
NEW BEDFORD HARBOR

GEOTECHNICAL

TESTED BY	CHECKED BY	PROJ NO
KM		4959-19
	DATE 2-18-88	B-15

JGA 003
1 APR 82

JORDAN GORRILL ASSOCIATES
GEOTECHNICAL CONSULTANTS



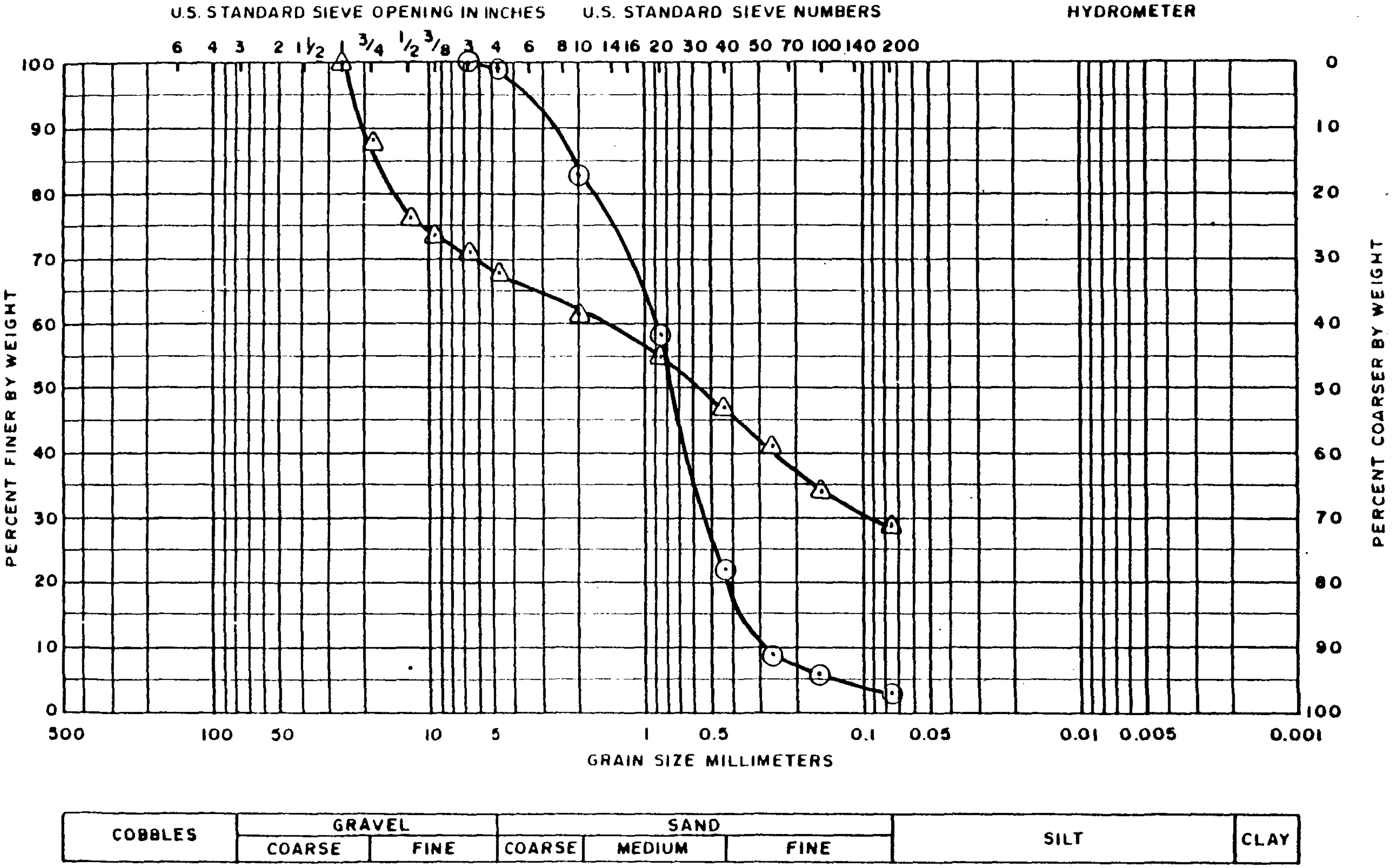
SAMPLE NO.	ELEV. OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
BL 105 S3	⬡ 6-8'	SP Brown sand, trace silt	21.4			

GRAIN SIZE DISTRIBUTION CURVES

PRELIMINARY GEOTECHNICAL INVESTIGATION
NEW BEDFORD HARBOR SUPERFUND SITE

TESTED BY	CHECKED BY	PROJ NO
TS	PD	4959-19
	DATE 4-1-88	B-16

JGA 003
1 APR 82



SAMPLE NO.	ELEV. OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
BL106 S3	△ 6-8'	SM Brown sand, some gravel & silt	39.0			
BL106 ·S7	⊙ 14-16'	SP Gray sand, trace gravel and silt	34.1			

GRAIN SIZE DISTRIBUTION CURVES

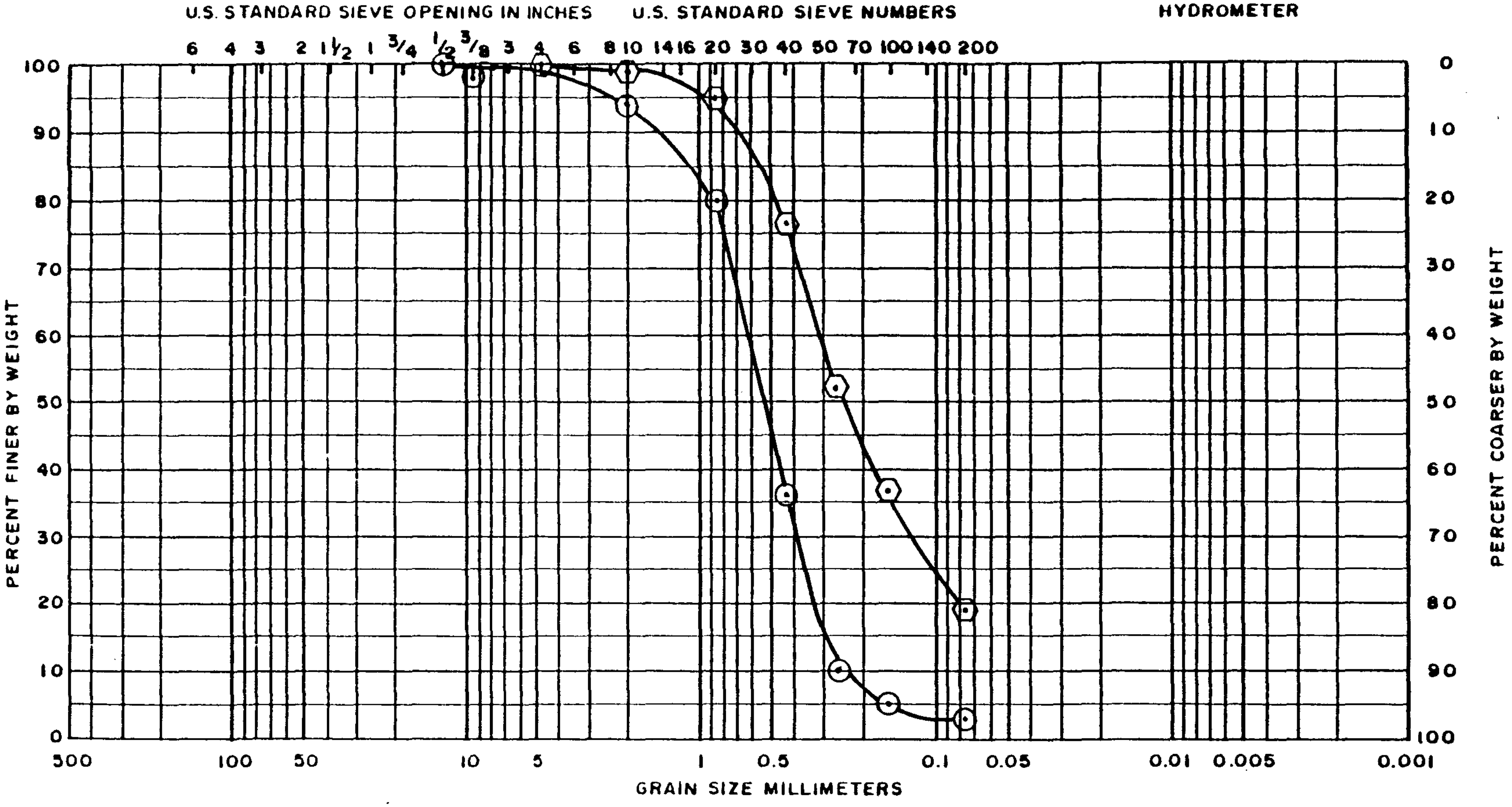
NEW BEDFORD HARBOR

GEOTECHNICAL

TESTED BY	CHECKED BY	PROJ NO
KM		4959-19
	DATE 2-18-88	B-17

JGA 003
1 APR 82

JORDAN GORRILL ASSOCIATES
GEOTECHNICAL CONSULTANTS



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<tr><td rowspan="2">COBBLES</td><td colspan="2">GRAVEL</td><td colspan="3">SAND</td><td rowspan="2">SILT</td><td rowspan="2">CLAY</td></tr>
<tr><td>COARSE</td><td>FINE</td><td>COARSE</td><td>MEDIUM</td><td>FINE</td></tr>
</table>

SAMPLE NO.	ELEV. OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
BL 107 S6	⬡ 12-14'	SM Olive sand, little silt	39.5			
BL 107 S8	⊙ 20-22'	SP Brown sand, trace gravel and silt	18.2			

JGA 003
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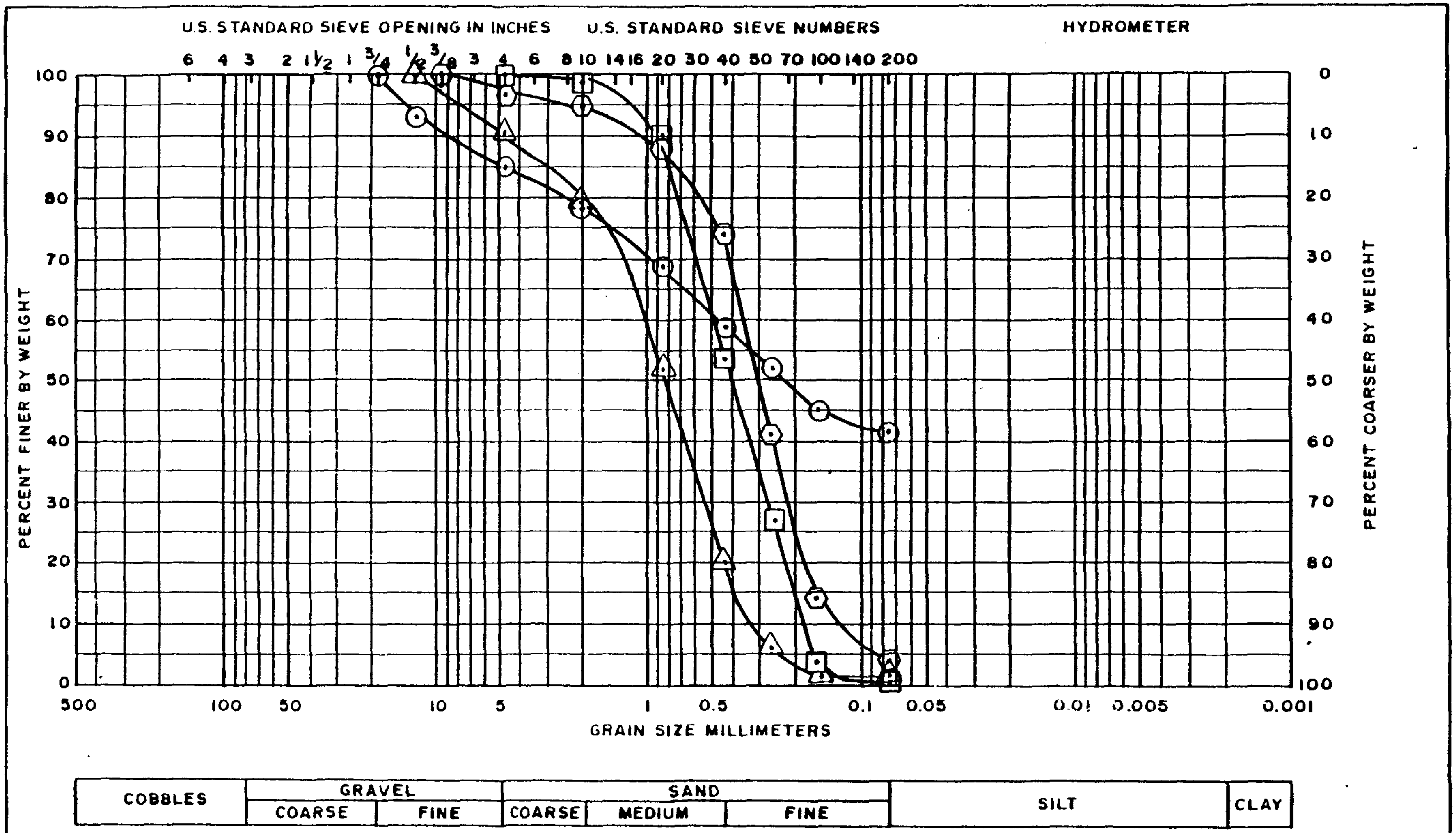
GRAIN SIZE DISTRIBUTION CURVES

PRELIMINARY GEOTECHNICAL INVESTIGATION
NEW BEDFORD HARBOR SUPERFUND SITE

TESTED BY	CHECKED BY	PROJ NO.
TS	PD	4959-19
	DATE 4-1-88	B-18



SAMPLE NO.	ELEV. OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
BL108 S1	⬡ 2-4'	SP Brown sand, trace gravel and silt	19.6			
BL108 S4	⊙ 8-10'	SM Olive silty sand, little gravel	22.6			
BL108 S7	⊡ 14-16'	SP Olive sand	31.0			
BL108 S9	△ 25-27'	SP Grayish-brown sand, trace gravel and sand	15.3			

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1 APR 82

GRAIN SIZE DISTRIBUTION CURVES

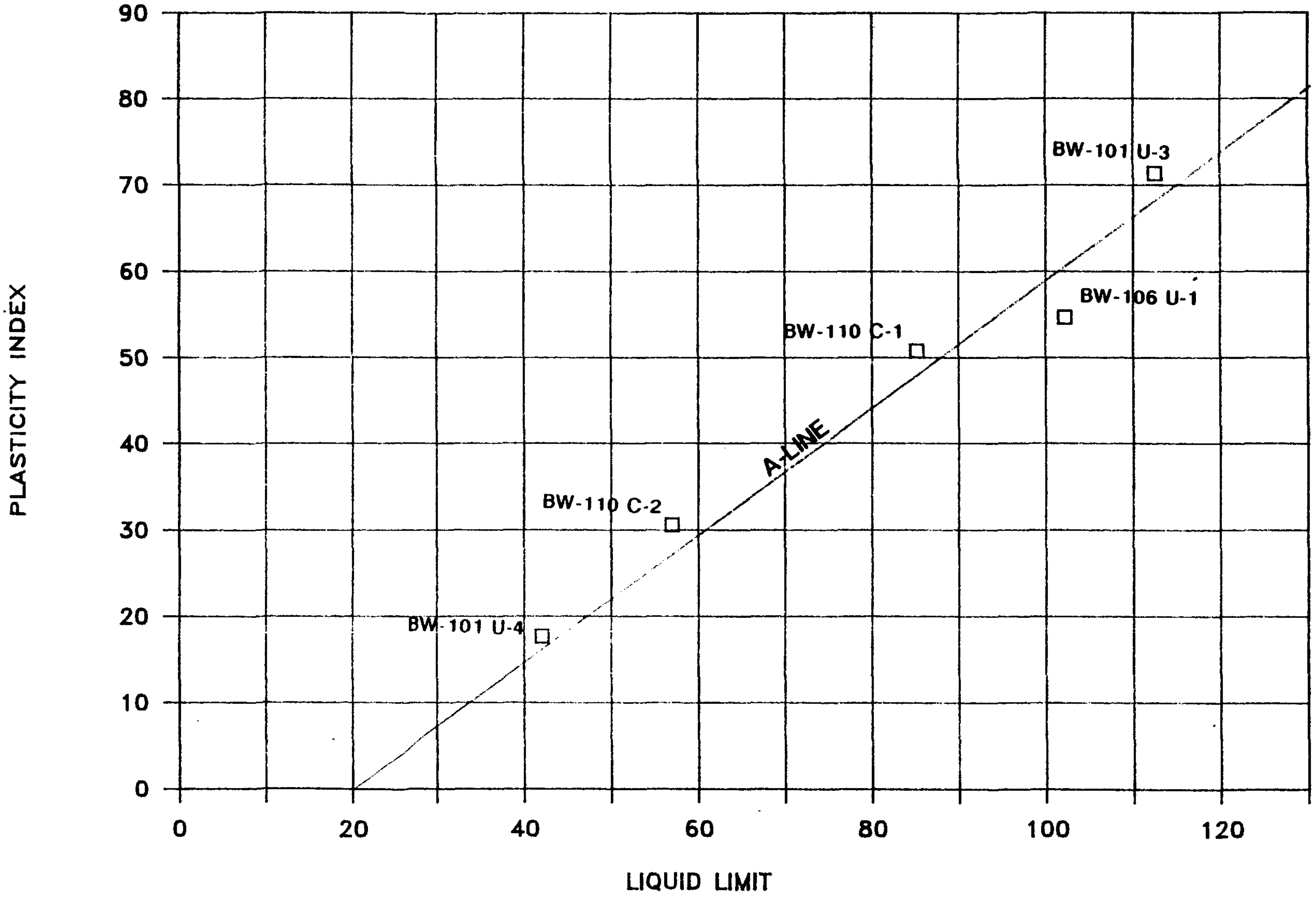
PRELIMINARY GEOTECHNICAL INVESTIGATION
NEW BEDFORD HARBOR SUPERFUND SITE

TESTED BY TS	CHECKED BY PD	PROJ NO 4959-19
	DATE 4-1-88	B-19

APPENDIX C

ATTERBERG LIMIT DATA

PLASTICITY CHART



PROJECT NEW BEDFORD GEOTECHNICAL BW101 U3 6-8'	COMP. BY RS	JOB NO. 4959-19
	CHK. BY PD	DATE 3-22-88

ATTERBERG LIMITS

WATER CONTENT (W_n)

DETERMINATION NO.			1
TARE NO.			126
WT. IN GRAMS	TARE PLUS WET SOIL		34.4
	TARE PLUS DRY SOIL		25.95
	WATER	W_w	8.5
	TARE		18.1
	DRY SOIL	W_s	7.9
WATER CONTENT, %		W	107.6

PLASTIC LIMIT (W_p)

1	
139	168
20.25	20.2
19.3	19.25
1.0	1.0
17.0	16.95
2.3	2.3
41.3	41.3

LIQUID LIMIT (W_l)

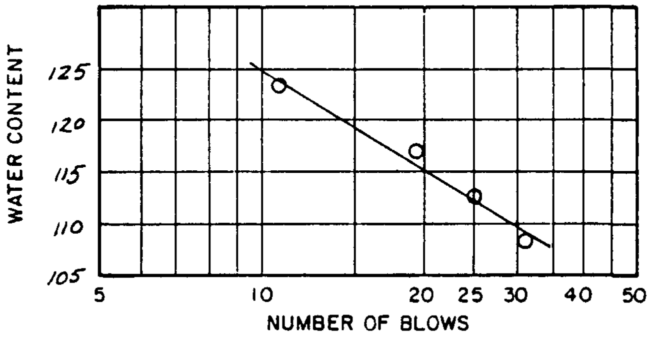
DETERMINATION NO.			1	2	3	4	5
NO. OF BLOWS			36	25	19	11	
TARE NO.			129	124	114	149	
WT. IN GRAMS	TARE PLUS WET SOIL		25.4	25.8	26.15	24.2	
	TARE PLUS DRY SOIL		22.05	21.5	22.1	19.8	
	WATER	W_w	3.4	4.3	4.1	4.4	
	TARE		18.95	17.7	18.65	16.2	
	DRY SOIL	W_s	3.1	3.8	3.5	3.6	
WATER CONTENT, %		W	108.1	113.2	117.4	122.2	

RESULT SUMMARY

NATURAL WATER CONTENT	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
107.6	112.5	41.3	71.2

REMARKS ____________________

FLOW CURVE



PROJECT	COMP. BY	JOB NO.
NEW BEDFORD GEOTECHNICAL BW101 U4 12-14'	RS	4959-19
	CHK. BY PD	DATE 3-22-88

ATTERBERG LIMITS

WATER CONTENT (W_n)

DETERMINATION NO.			1
TARE NO.			145
WT. IN GRAMS	TARE PLUS WET SOIL		37.4
	TARE PLUS DRY SOIL		32.25
	WATER	W_w	5.2
	TARE		17.8-
	DRY SOIL	W_s	14.5
WATER CONTENT, %		W	35.6

PLASTIC LIMIT (W_p)

1	
110	142
20.1	26.1
19.25	24.35+
0.9	1.8
15.7-	17.25
3.6	7.1
23.9	24.6

AVG = 24.3

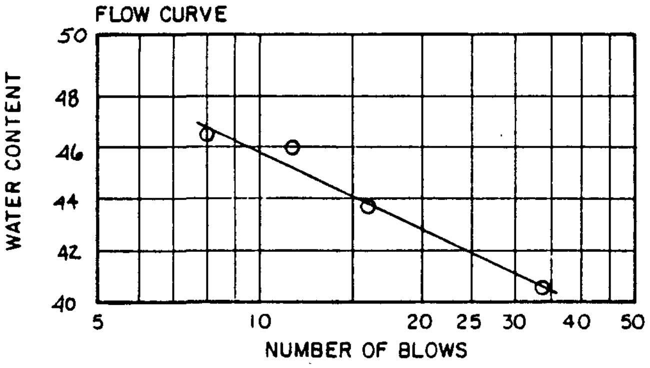
LIQUID LIMIT (W_l)

			1	2	3	4	5
DETERMINATION NO.			1	2	3	4	5
NO. OF BLOWS			34	12	8	16	
TARE NO.			112	125	133	106	
WT. IN GRAMS	TARE PLUS WET SOIL		23.2	29.0	25.7	24.4	
	TARE PLUS DRY SOIL		21.1	26.1	23.2	21.5	
	WATER	W_w	2.1	2.9	2.5	2.9	
	TARE		15.9	19.8-	17.8-	14.9	
	DRY SOIL	W_s	5.2	6.3	5.4	6.6	
WATER CONTENT, %		W	40.4	46.0	46.3	43.9	

RESULT SUMMARY

NATURAL WATER CONTENT	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
35.6	42.0	24.3	17.7

REMARKS ______



PROJECT	COMP. BY	JOB NO.
NEW BEDFORD GEOTECHNICAL BW 106 U1 6-8'	RS	4959-19
	CHK. BY PD	DATE 3-22-88

ATTERBERG LIMITS

WATER CONTENT (W_n)

DETERMINATION NO.			1
TARE NO.			128
WT. IN GRAMS	TARE PLUS WET SOIL		42.5
	TARE PLUS DRY SOIL		31.2 +
	WATER	W_w	11.3
	TARE		18.0 +
	DRY SOIL	W_s	13.2
WATER CONTENT, %		W	85.6

PLASTIC LIMIT (W_p)

1	
164	115
20.1 -	22.3 -
18.9 +	20.8 -
1.2	1.5
16.4 -	17.6 -
2.5	3.2
48.0	46.9

AVG = 47.5

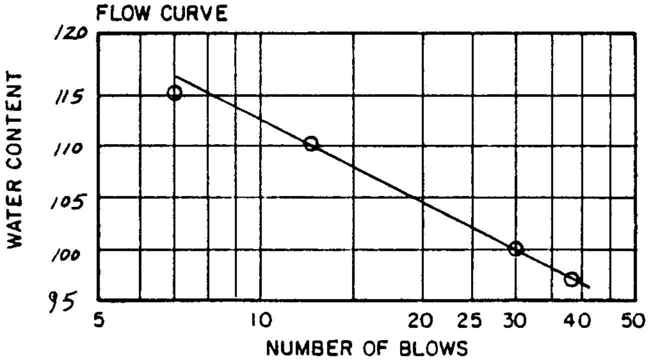
LIQUID LIMIT (W_l)

			1	2	3	4	5
DETERMINATION NO.			1	2	3	4	5
NO. OF BLOWS			38	30 +	13	7	
TARE NO.			144	123	121	120	
WT. IN GRAMS	TARE PLUS WET SOIL		24.1 +	24.8 +	26.2	24.5	
	TARE PLUS DRY SOIL		20.65	21.05	22.0 +	20.75	
	WATER	W_w	2.0	3.8	4.2	3.8	
	TARE		17.1	17.3 +	18.2	17.5	
	DRY SOIL	W_s	3.5	3.8	3.8	3.3	
WATER CONTENT, %		W	97.2	100.0	110.5	115.4	

RESULT SUMMARY

NATURAL WATER CONTENT	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
85.6	102.2	47.5	54.7

REMARKS



PROJECT NEW BEDFORD GEOTECHNICAL BW 110 C1 2-4'	COMP. BY RS	JOB NO. 4959-19
	CHK. BY PD	DATE 3-22-88

ATTERBERG LIMITS

WATER CONTENT (W_n)

DETERMINATION NO.			1
TARE NO.			170
WT. IN GRAMS	TARE PLUS WET SOIL		39.1
	TARE PLUS DRY SOIL		28.93
	WATER	W_w	10.2
	TARE		17.5
	DRY SOIL	W_s	11.4
WATER CONTENT, %		W	89.0

PLASTIC LIMIT (W_p)

1	
158	118
20.5	22.2
19.77	21.27
0.7	0.9
17.7-	18.5+
2.1	2.8
35.3	33.6

AVG = 34.4

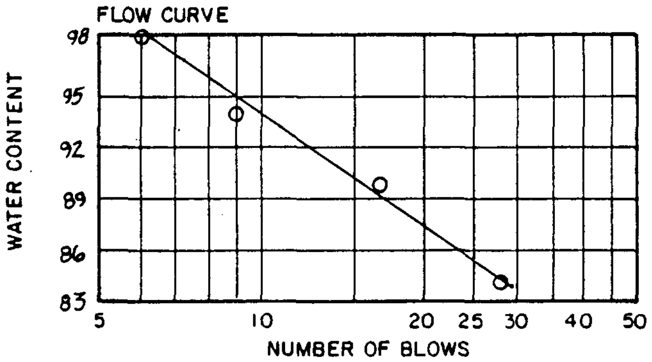
LIQUID LIMIT (W_l)

			1	2	3	4	5
DETERMINATION NO.			1	2	3	4	5
NO. OF BLOWS			28	17	9	6	
TARE NO.			131	103	134	167	
WT. IN GRAMS	TARE PLUS WET SOIL		25.32	24.3-	27.3	27.3	
	TARE PLUS DRY SOIL		21.4	20.07	22.7	22.35	
	WATER	W_w	3.9	4.2	4.6	5.0	
	TARE		16.73	15.35	17.8+	17.3+	
	DRY SOIL	W_s	4.7	4.7	4.9	5.1	
WATER CONTENT, %		W	83.9	89.6	93.9	98.0	

RESULT SUMMARY

NATURAL WATER CONTENT	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
89.0	85.2	34.4	50.8

REMARKS ______________________________



PROJECT	COMP. BY	JOB NO.
NEW BEDFORD GEOTECHNICAL	RS	4959-19
BW 110 C2 6-8'	CHK. BY PD	DATE 3-22-88

ATTERBERG LIMITS

WATER CONTENT (W_n)

DETERMINATION NO.			1
TARE NO.			151
WT. IN GRAMS	TARE PLUS WET SOIL		47.3+
	TARE PLUS DRY SOIL		35.03
	WATER	W_w	12.3
	TARE		17.2-
	DRY SOIL	W_s	17.8
WATER CONTENT, %		W	68.8

PLASTIC LIMIT (W_p)

1	
113	156
23.55	22.05
22.63	21.0
0.9	1.1
19.15	17.0+
3.5	4.0
26.4	26.3

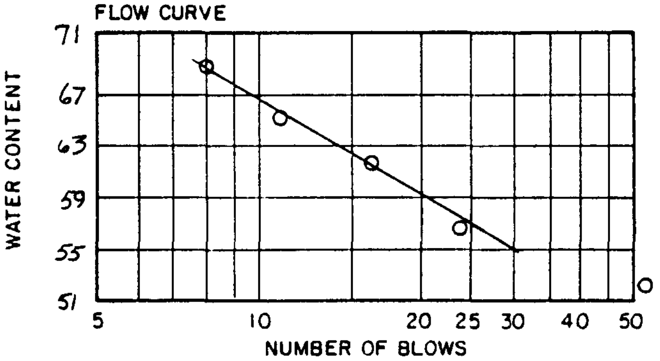
LIQUID LIMIT (W_l)

DETERMINATION NO.			1	2	3	4	5
NO. OF BLOWS			16	11	8	55	24
TARE NO.			155	171	109	135	152
WT. IN GRAMS	TARE PLUS WET SOIL		30.13	29.0	27.9	25.83	29.0
	TARE PLUS DRY SOIL		25.27	24.1	22.93	23.1	25.0+
	WATER	W_w	4.9	4.9	5.0	2.7	4.0
	TARE		17.37	16.55	15.75	17.83	18.0
	DRY SOIL	W_s	7.9	7.6	7.2	5.3	7.0
WATER CONTENT, %		W	61.5	64.9	69.2	51.8	57.1

RESULT SUMMARY

NATURAL WATER CONTENT	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
68.8	57.0	26.4	30.6

REMARKS ______________________________



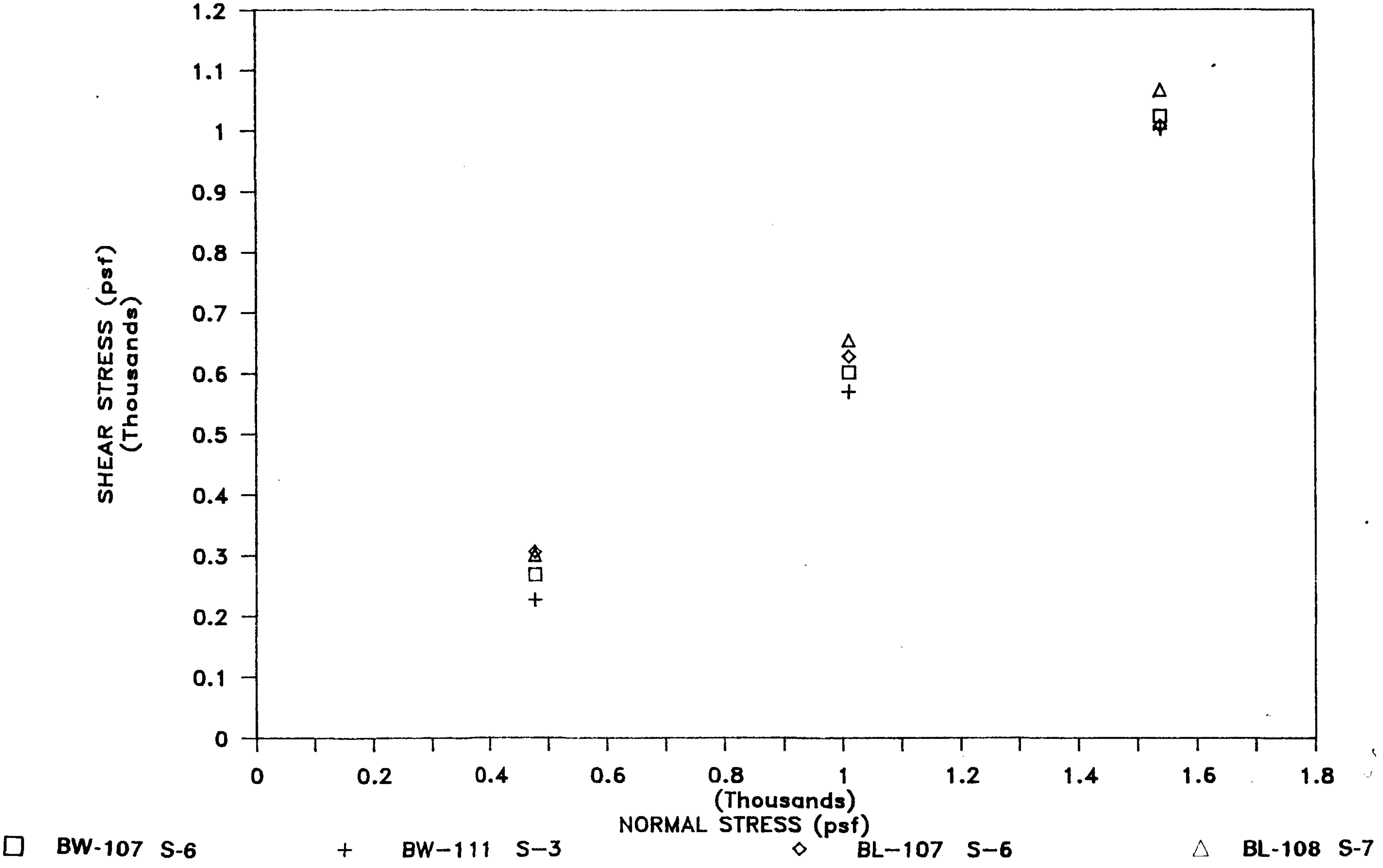
SHEET C-6

E.C. JORDAN CO. ENGINEERS & SCIENTISTS

APPENDIX D

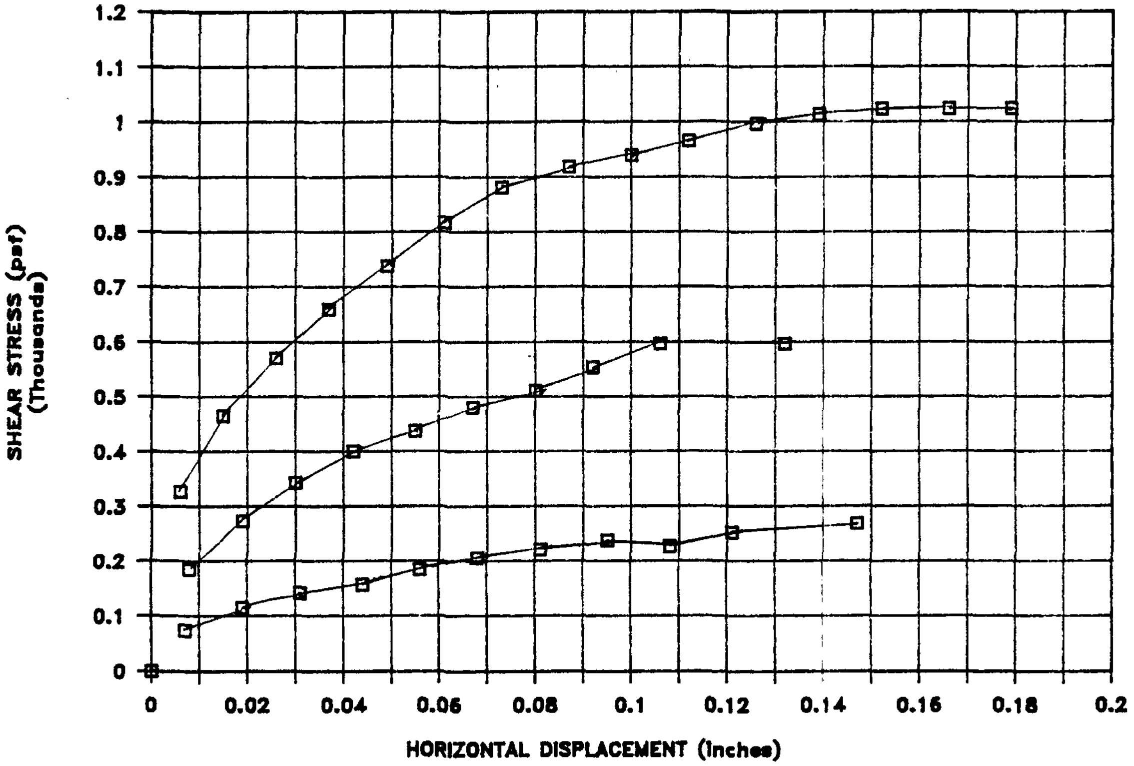
DIRECT SHEAR DATA

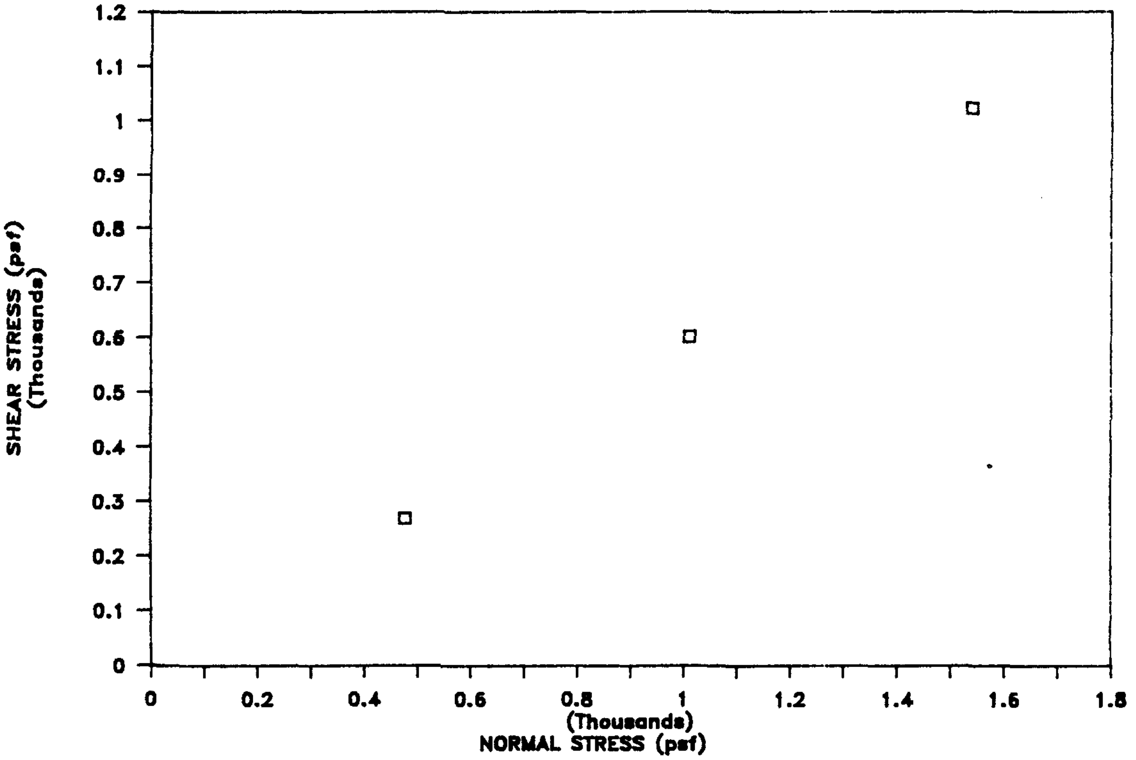
SUMMARY SHEET



DIRECT SHEAR TEST DATA

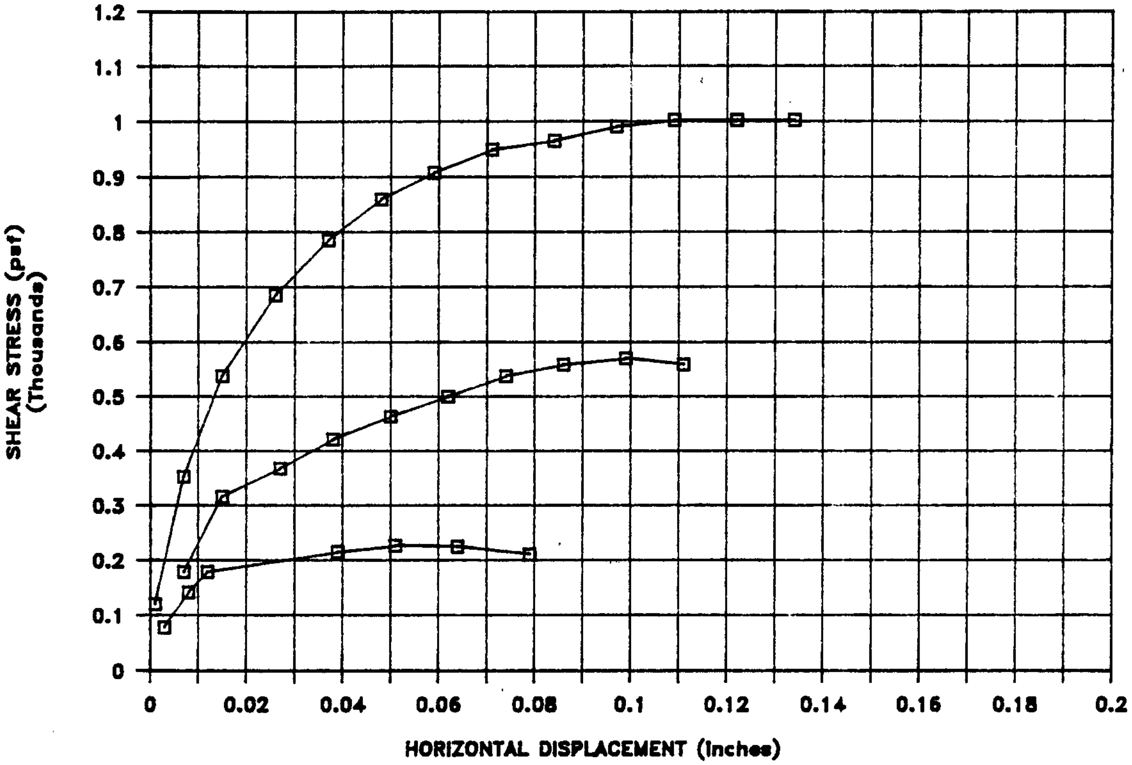
BORING NO. BW-107 SAMPLE NO. S-6

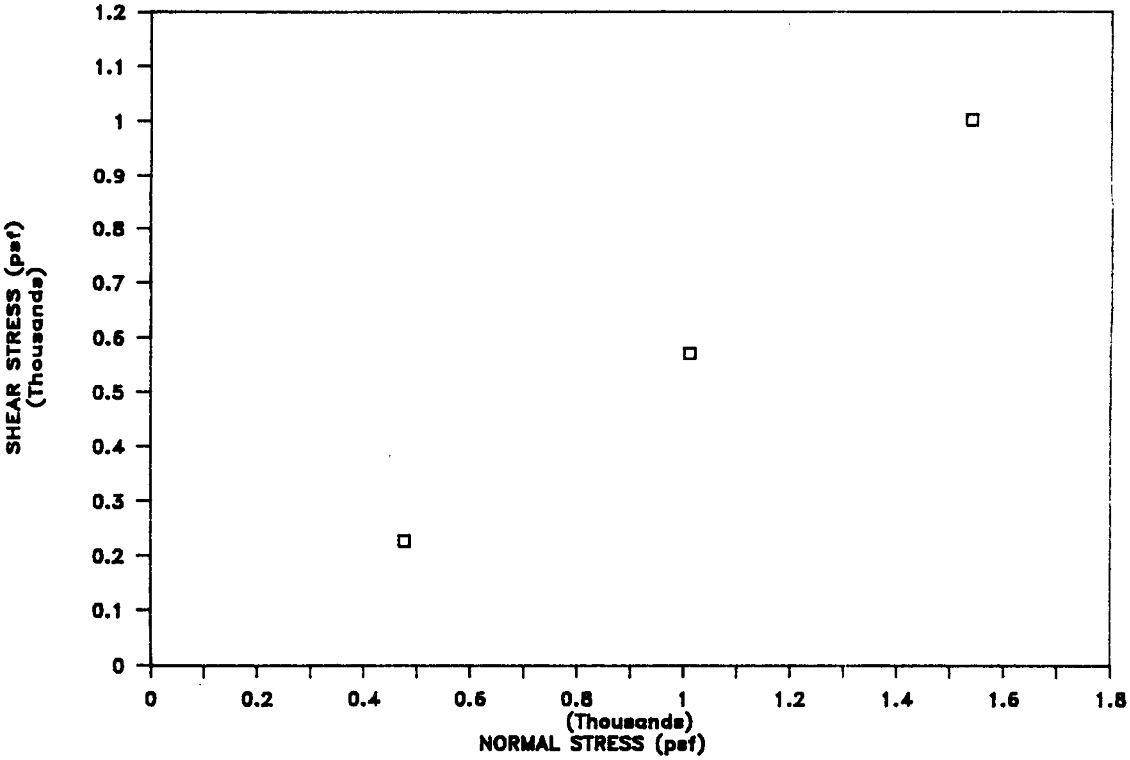




DIRECT SHEAR TEST DATA

BORING NO. BW-111 SAMPLE NO. S-3

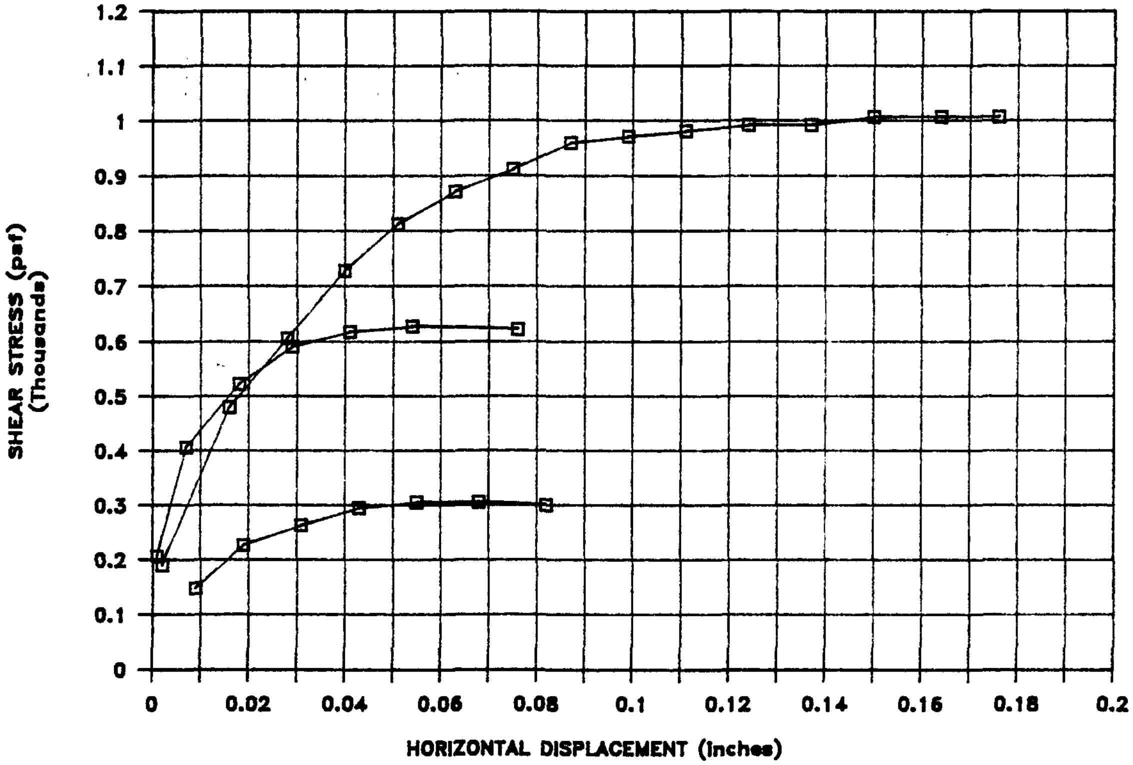


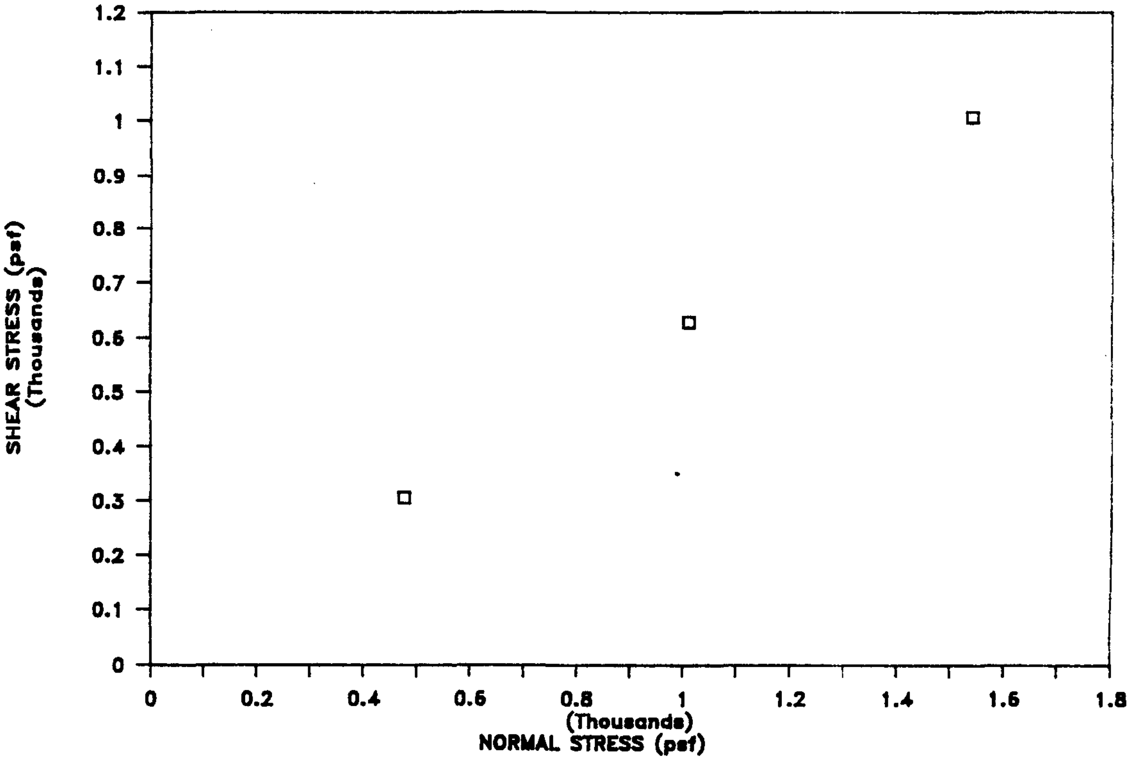


SHEET D-3

DIRECT SHEAR TEST DATA

BORING NO. BL-107 SAMPLE NO. S-6

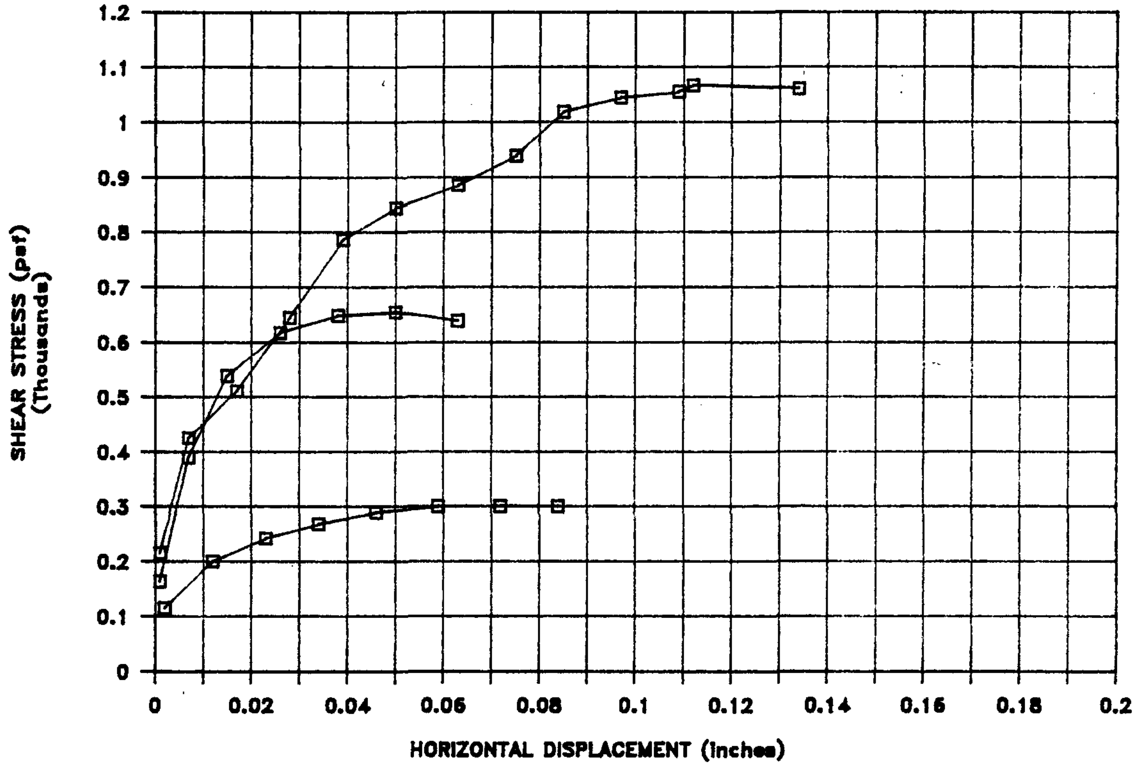


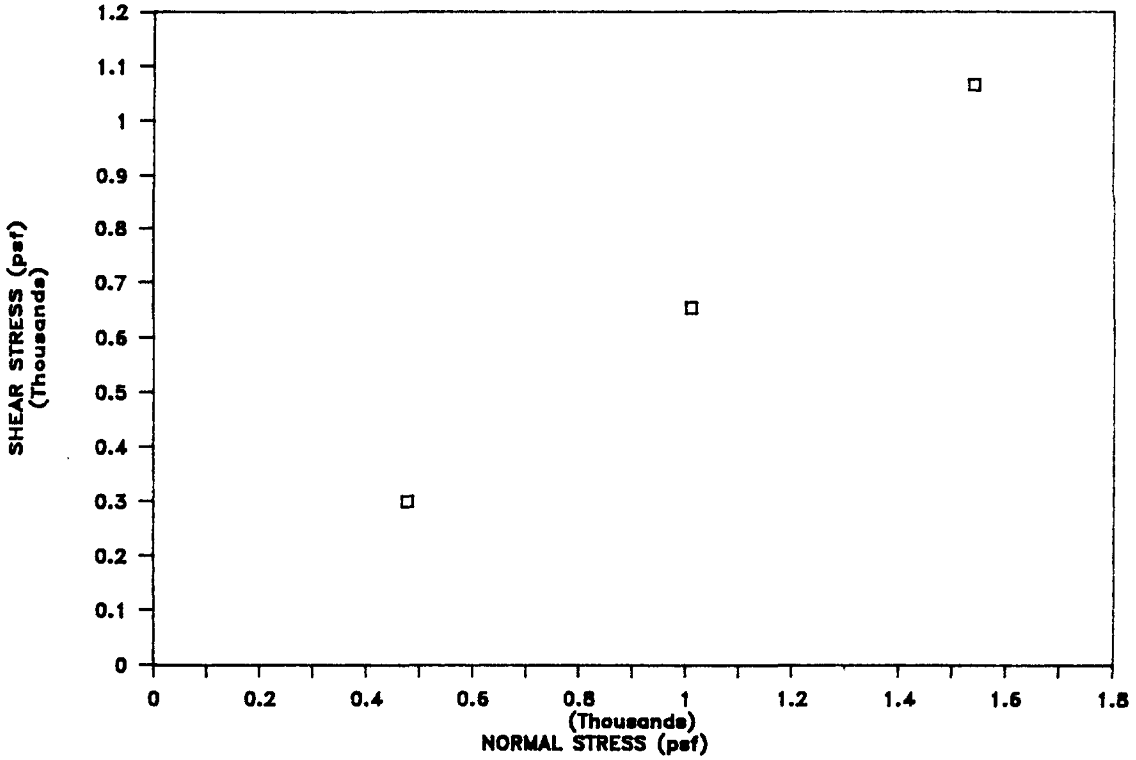


SHEET D-4

DIRECT SHEAR TEST DATA

BORING NO. BL-108 SAMPLE NO. S-7

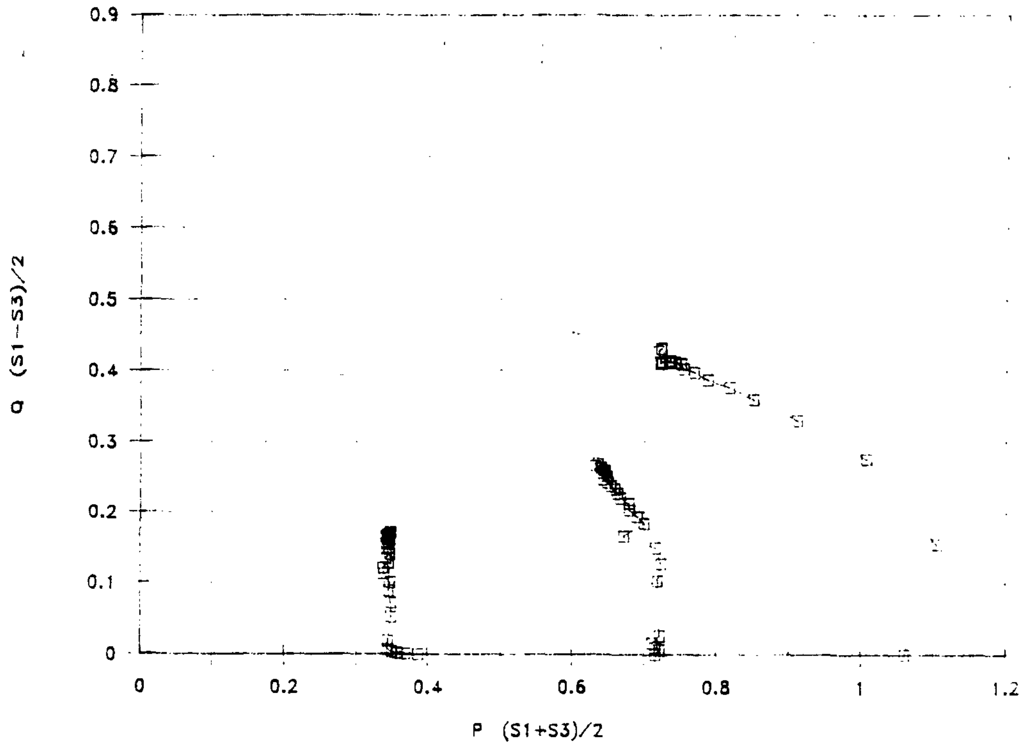




APPENDIX E

STAGED TRIAXIAL TESTING DATA

P-Q DIAGRAM



STAGE ONE TESTING

AXIAL STRAIN	DEV STRESS (KG/CM2)	SIGMA 3 (KG/CM2)	SIGMA 1 (KG/CM2)	Q (S1-S3)/2	P (S1+S3)/2
0.0000	0.000	0.356	0.355	0.000	0.356
0.0007	0.003	0.365	0.369	0.002	0.363
0.0010	0.003	0.355	0.359	0.002	0.358
0.0017	0.007	0.344	0.353	0.003	0.349
0.0027	0.007	0.345	0.353	0.003	0.347
0.0037	0.013	0.336	0.349	0.007	0.343
0.0044	0.037	0.326	0.363	0.018	0.344
0.0051	0.104	0.295	0.400	0.052	0.348
0.0057	0.144	0.275	0.420	0.072	0.349
0.0065	0.179	0.255	0.434	0.087	0.345
0.0077	0.201	0.246	0.447	0.100	0.345
0.0085	0.224	0.226	0.450	0.112	0.338
0.0096	0.241	0.216	0.457	0.120	0.336
0.0105	0.257	0.215	0.473	0.129	0.345
0.0115	0.272	0.205	0.476	0.135	0.341
0.0125	0.292	0.205	0.495	0.140	0.345
0.0135	[illegible]	0.195	0.489	0.146	[illegible]
0.0145	0.299	0.195	0.495	0.150	[illegible]
0.0157	0.309	0.186	0.495	0.154	0.340
0.0167	0.315	[illegible]	0.501	0.159	0.344
0.0179	0.322	0.186	0.508	0.161	0.347
0.0192	0.329	0.175	0.504	0.164	0.340
0.0193	0.331	0.176	0.507	0.165	0.341
[illegible]	0.334	0.176	0.510	0.167	0.343
0.0204	[illegible]	0.175	0.517	0.169	0.345
0.0207	0.340	0.175	0.516	0.170	0.345
0.0212	[illegible]	0.174	0.517	0.172	0.347
[illegible]	0.345	[illegible]	0.522	0.177	[illegible]

STAGE TWO TESTING

AXIAL STRAIN	DEV STRESS (KG/CM2)	SIGMA 3 (KG/CM2)	SIGMA 1 (KG/CM2)	Q (S1-S3)/2	P (S1+S3)/2
0.0000	0.000	0.715	0.715	0.000	0.715
0.0009	0.013	0.715	0.729	0.007	0.722
0.0020	0.020	0.705	0.725	0.010	0.715
0.0032	0.033	0.695	0.729	0.016	0.711
0.0041	0.052	0.695	0.747	0.025	0.721
0.0057	0.205	0.615	0.921	0.103	0.719
0.0062	0.255	0.595	0.950	0.128	0.723
0.0071	0.301	0.565	0.866	0.150	0.715
0.0082	0.333	0.505	0.838	0.167	0.672
0.0091	0.369	0.515	0.884	0.184	0.699
0.0100	0.389	0.495	0.883	0.194	0.689
0.0109	0.407	0.475	0.882	0.204	0.679
0.0120	0.426	0.455	0.871	0.213	0.663
0.0129	0.442	0.445	0.887	0.221	0.666
0.0139	0.455	0.435	0.870	0.227	0.662
0.0149	0.467	0.425	0.872	0.234	[illegible]
0.0159	0.476	0.415	0.891	0.238	0.653
0.0171	0.495	0.395	0.891	0.247	0.648
0.0180	[illegible]	0.395	0.970	0.247	0.647
0.0193	0.504	0.395	[illegible]	0.252	0.647
0.0203	0.517	0.395	0.898	0.254	0.641
0.0214	0.517	[illegible]	0.904	0.257	0.644
0.0225	0.525	[illegible]	0.900	0.262	[illegible]
0.0235	[illegible]	[illegible]	0.922	0.264	[illegible]
0.0249	0.533	[illegible]	[illegible]	[illegible]	[illegible]
0.0257	[illegible]	[illegible]	0.904	[illegible]	[illegible]

STAGE THREE TESTING

AXIAL STRAIN	DEV STRESS (KG/CM2)	SIGMA 3 (KG/CM2)	SIGMA 1 (KG/CM2)	Q (S1-S3)/2	P (S1+S3)/2
0.0000	0.000	1.060	1.060	0.000	1.060
0.0079	0.310	0.950	1.260	0.155	1.105
0.0091	0.553	0.730	1.283	0.277	1.007
0.0170	0.651	0.590	1.241	0.321	0.911
0.0191	0.721	0.490	1.211	0.361	0.851
0.0225	0.755	0.440	1.195	0.377	0.817
0.0251	0.775	0.400	1.175	0.388	0.788
0.0345	0.795	0.370	1.166	0.399	0.763
0.0403	0.806	0.350	1.156	0.403	0.753
0.0459	[illegible]	0.340	1.160	0.410	0.750
0.0513	0.821	0.330	1.154	0.412	0.742
0.0570	0.825	0.320	1.146	0.413	0.733
0.0625	0.830	0.320	1.150	0.415	0.735
0.0693	0.828	0.320	1.148	0.414	0.734
0.0738	0.825	0.310	1.135	0.413	0.723
[illegible]	0.827	0.310	1.137	0.413	0.723
0.0750	0.824	0.310	1.134	0.412	0.722
[illegible]	0.822	0.310	1.132	0.412	0.722
0.0871	0.825	0.310	1.135	0.413	0.723
0.0885	0.824	0.310	1.134	0.412	0.722
[illegible]	0.827	0.312	1.133	0.412	0.722
[illegible]	0.822	0.310	1.132	0.411	0.721
0.0719	0.824	0.310	1.131	0.412	0.722
[illegible]	[illegible]	0.270	1.148	0.427	[illegible]
0.1027	[illegible]	0.290	1.155	[illegible]	[illegible]
0.1071	[illegible]	0.290	1.155	[illegible]	[illegible]

SHEET E-1

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